THE ENGINEER

APRIL 23, 1954

National Institute of Agricultural Engineering

THE National Institute of Agricultural Engineering, which is situated at Wrest Park, Silsoe, Bedfordshire, has just issued a report which records its activities during the year ended September 30, 1952. The work of the several departments of the Institute continues under the guidance of the director, Mr. W. H. Cashmore. The report says that in the period reviewed, twenty-seven tests were carried out in the agricultural testing department, the classes of machine selected for testing techniques being those in the greatest demand in present-day farm mechanisation. In the mechanical engineering department, twenty-nine tractor test reports were issued during the year, and good progress was made with work on the development of a hydraulic transmission system. The report gives a general description of this development work, for which a hydraulic motor fitting inside a 9×32 pneumatic tyred wheel has been built. The head of the mechanical engineering department, Mr. H. J. Hamblin, has said, in a record of the work so far done, that if a wheel motor can be developed to reach an efficiency of 92 per cent, which seems a reasonable goal, then the overall efficiency of the hydrostatic transmission may reach as high a figure as 87 per cent, which is considerably in excess of the minimum acceptable and is equal to that of most mechanical transmissions. During the year reviewed, it was decided, in connection with the hydraulic transmission work, to design an experimental tractor. A medium-powered tractor is therefore being converted to hydraulic transmission with the minimum of incidental alteration. The report includes also some account of the work done at the Scottish Machinery Testing Station at Howden, under the direction of Mr. W. J. West. In the course of its work, this station makes investigations specially applicable to Scotland, such as those concerned with land reclamation and improvement and the behaviour of implements and machines on sloping ground.

Diesel Engine Users Association Annual Luncheon

ABOUT 200 members and guests attended the annual luncheon of the Diesel Engine Users Association, which was held at the Connaught Rooms, Great Queen Street, London, on Thursday, April 15th. The president, Mr. F. J. Mayor, gave the loyal toast and then presented the Percy Still Medal to Mr. H. D. Adam for his paper, "Preventive Maintenance from Breakdown Experience." Mr. Mayor, in proposing the toast of "Our Guests," made individual reference to the former presidents of the Association, who were present and briefly recalled some of the interesting visits to various technical establishments in which the members had participated. The principal guest, Professor S. J. Davies, D.Sc., Ph.S., of King's College, London, replied, and proposed the toast of "The Association," and during the course of his remarks paid tribute to the pioneer work of Mr. Mayor in developing diesel, diesel-electric and diesel-hydraulic forms of main power unit for the propulsion of Thames's tugs. He mentioned the rapid expansion of the use of the diesel engine and the advances made in this country in design and production of compression-ignition engines. After commenting that much of the work carried out by research associations, private firms and universities was usually taken for granted, Professor Davies commended the part played by the technical Press, and then went on to discuss the present position in the universities from the standpoint of a teacher. He deplored the fact that, despite the fact that this was a highly industrialised country, we were training only about half the number of men needed by industry and hoped that more boys could be induced to enter the profession from school. To-day, in the engineering works, he remarked, more and more mechanical aids were available to assist the hand worker, so that fewer were required and, therefore, this fact emphasised the urgent need for more trained engineers. Mr. W. Howes proposed the "Vote of Thanks to the President," and commented upon Mr. Mayor's fifty years association with London's river, and his work in developing the diesel engine as the main propulsion of the Thames's tugs.

Institute of Seaweed Research

THE annual report, for 1953, of the Institute of Seaweed Research, at Inveresk, records steady progress in all branches of the work. The report says also that last year was a period of increased stability and output in the British seaweed utilisation industry, which was working to capacity in the production of alginates, fertilisers and animal foodstuffs. There are now six seaweed-processing units in Scotland, three of which have been set up since the end of the war, and their operations have resulted in increased employment in the Outer Isles and on the West Coast as well as in Orkney and the Moray Firth area. A new seaweed meal factory went into production at Kirkwall early in the year. One chapter of the report is devoted to the work of the Institute's mechanical engineering department. The main effort of the department, it is stated, was again directed to the development of continuous harvesting machinery for brown sublittoral seaweed. A large experimental continuous grapnel or belt harvester was operated at sea for over 100 hours, the first time that this has been possible with sub-littoral seaweed of the kind common to Scotland as well as to Norway, France, Nova Scotia, and Japan. It is also reported that during last year, for the first time, investigation of the problems associated with seaweed harvesting were being made on a model scale in a laboratory tank. Early last year it was decided to apply this technique to the solution of the outstanding problems in the cutting and entrainment or suction method. With this object in view, a tank and model cutting heads have been designed and constructed, and a number of exploratory investigations completed under controlled conditions. Another comment in this section of the report is that, as in former years, much of the time of the engineering department was devoted to the modification, repair and maintenance of boats, plant, machinery, apparatus and buildings. This work, it is noted, was considerably facilitated by the conversion of the Institute's "Land Rover" to a mobile welding and power plant.

Water Pollution Research

THE Water Pollution Research Laboratory of the D.S.I.R. has published its annual report for 1953, which gives an account of the progress made during that year on various researches. A large proportion of the work of the Laboratory during the year was concerned with a study of the condition of the Thames estuary. The main work was concentrated on attempts to determine the factors affecting the rate at which dissolved oxygen is used up in the oxidation of organic matter and the rate at which it is replaced from various sources. For example, the effect of temperature on the rate of oxidation of polluting matter has been examined, the rate of absorption of oxygen from the air has been measured, and the possible effect of photosynthesis in increasing the content of dissolved oxygen has been investigated. Automatic equipment has been developed to facilitate the work of various sections of the Laboratory, the apparatus devised including automatic samplers, a submersible turbidimeter, and apparatus for automatic control of pH value. One of the subjects investigated at the Laboratory and described in the report concerns the effect of water treatment processes on radio isotopes; the removal of radio strontium is described. The effect of pollution on fish was also investigated, and a survey was in progress on the River Colne, where the effluent from the Colne Valley sewage works is carried with little dilution, and where there are sometimes large numbers of fish. Investigations on industrial waste waters concerned the biological treatment of cyanides, the treatment of spent liquor from gasworks, and the black liquor from the keiring of cotton. Further work was carried out on the efficiencies of percolating filters for sewage purification. The report points out that there is an optimum rate of movement for a distributor, which for a circular filter may be lower than that commonly found at a sewage works, when rotating distributors are driven by reaction jets. For example, in four large circular filters at Birmingham the optimum rate of rotation of the four-armed distributors appeared to be one revolution in fifteen to thirty minutes. With this rate the filters become much less ponded, and the quality of the final effluent is much better than when the distributors revolve more rapidly.

Survey of Canals and Inland Waterways

IN the course of the recent debate in Parliament on increased freight charges, the Minister of Transport and Civil Aviation, Mr. A. T. Lennox-Boyd, made reference to the need for another examination of this country's canal system. He said that the British Transport Commission had already reached the conclusion that such a survey would be desirable. It would be carried out, the Minister added, by a member of the Transport Commission and someone outside the Commission with wide experience of transport methods and practices. This week, the Commission has announced the appointment of a small board to carry out the survey. Lord Rusholme is to act as chairman, and the two other members of the board are Sir Rex Hodges and Mr. R. D. Brown, M.I.C.E. The board's terms of reference are "to survey the use at present being made of the British Transport Commission's inland waterways, and to report as to whether all possible steps are being taken to ensure that the maximum economic advantage is being derived, and as to steps which can be taken in respect of such of the inland waterways as can no longer be put to economic commercial use."

National Research Development Corporation

THE National Research Development Corporation, which was set up under the Development of Inventions Act, 1948, has now been operating for four years, its main function being to secure the development or exploitation of inventions resulting from research carried out with public funds. During the past four years the Corporation has acquired the patent rights in about 970 inventions evolved in Government research laboratories and university and research association laboratories. In order to improve the methods by which the Corporation brings these inventions to the notice of industry it has decided to produce a quarterly bulletin, the first number of which has just been published. This bulletin gives short notes of the inventions which have recently become available, together with notes on a selection of the inventions which have been the Corporation's property for some time. If copies of the relevant patent specifications are required, they may be obtained by making written application to the Exploitation Officer, National Research Development Corporation, 1, Tilney Street, London, W.1.

Fig. 7—Constructional Plant in the Val des Dix at the Site of Grande Dixence Dam

Fig. 8—Concrete Plant, Aggregate Silos and Winch House at Dam Site

Some Recent Swiss Hydro-Electric Schemes

No. III—(*Continued from page 555, April 16th*)

The constructional plant at Grande Dixence dam is unusually elaborate, and envisages a production of concrete of up to about 400 cubic yards per hour. Details of this plant installation are given in this instalment.

THERE is much that is standard in the plant installed for the preparation and handling of aggregates, and even for the manufacture of the concrete, at present-day constructional sites of this nature, where large quantities are involved. The plant at the Grande Dixence dam, therefore, necessarily has many points in common with the installations at other Swiss dam sites; it is, however, larger and more elaborate, so that some further description to amplify, first, the information given in Figs. 9 and 10 may not be out of place.

Aggregate Plant.—The primary crusher installation at the Prafleuri quarry consists of a single 42in gyratory crusher with a capacity of 800 tonnes per hour, for handling the largest sizes of excavated material. It is connected by belt conveyor to hoppers supplying eight 24in, 105 h.p. jaw crushers, each with a capacity of 100 tonnes per hour. Excavated material may also be tipped from trucks directly into these hoppers, there being a screen to keep out oversize material (greater than 23in), which goes to the gyratory crusher. From the feeders of these hoppers the material passes over a screen, which allows all stones of 120mm or less (the maximum aggregate size) to fall through to a second set of hoppers. The larger stones pass through the crushers to these same hoppers, where there are feeders supplying another belt conveyor which enters the tunnel to the dam site. There are two gyratory crushers installed in a chamber here, each with a capacity of 100 tonnes per hour, so that some of the material may be crushed again, to bring its sizes closer to the proportions required for concrete making. The conveyor system leading through the tunnel to the dam consists of a number of 36in troughed belts, each of the order of 300 yards long, with transfer conveyors between them.

Both at the quarry and the dam site, the slopes on which the plant is laid out have been utilised, so that the material flows by gravity through each stage of the various processes. A maximum output of 800 tonnes per hour is envisaged, but the units have been so arranged (with eight principal crushers in the installation described above, for instance) that outputs of three-quarters, one-half or one-quarter of that quantity may be obtained, with part of the plant in operation. How that principle has been applied to the layout of the washing, crushing and screening plant may be observed from a study of the elevation and the flow diagram of the plant shown in Figs. 9 and 10. All the material is washed as it passes through the screens, and the sand is

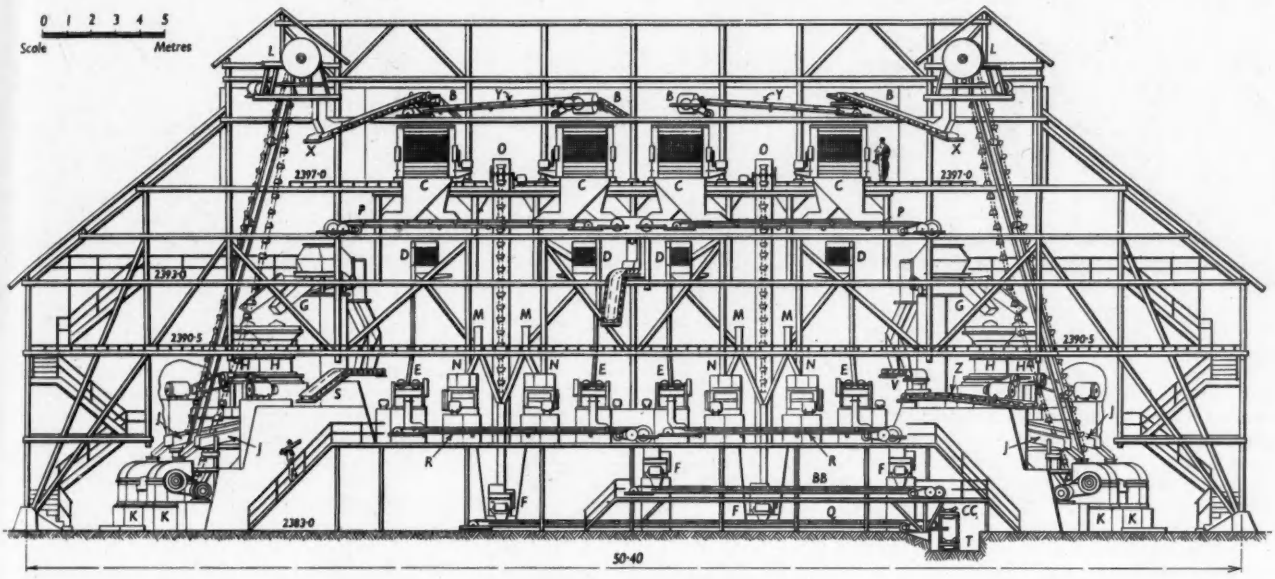


Fig. 9—Elevation of Aggregate Plant

Reference	Description of plant	No.	Capacity of each, cubic yards per hour
A	Feeders at stock yard, 0–120mm	16	32·5
B	Conveyor belts to aggregate plant, length 37m	4	130
C	Two-storied vibrating screens, 40–120, 10–40, and 0–10	4	156
D	Single-storied vibrating screens, 10–3, 0–3	4	52
E	Sand recovery plant, 0–3	4	195
F	"Weighto" feeders, sand, 0–3, 3–10	4	39
G	Regulating and feeding silos, 40–120	2	91
H	Gyratory crushers, 40–120	4	45
J	Single-storied vibrating screens, 10–40, 0–10	4	45
K	Hammer mill	4	19
L	Sand elevator, height 21m	2	91
M	Regulating and feeding silos, 3–10	4	13
N	Sand mills, 3–10, 0–3	4	13
O	Sand elevators, height 14m... ...	2	26
P	Conveyor belts, 40–120; length 10·5m	2	130
Q	Conveyor belts for sand, 3–10; length 19m	1	156
R	Conveyor belts for sand, 0–3; length 8·7m	2	39
S	Conveyor belts for coarse aggregate, 40–120; length 33·2m	1	130
T	Conveyor belt for sand, 3–10; length 33·1m	1	156
U	Conveyor belt for fine aggregate, 10–40; length 41·5m	1	130
V	Conveyor belt for coarse aggregate, 40–120; length 5·5m	1	130
W	Conveyor belt for fine aggregate, 10–40; length 9m	2	65
X	Conveyor belts for fine aggregate and sand, 0–10; length 7m	2	91
Y	Conveyor belts for fine aggregate and sand, 0–10; length 7m	2	45
Z	Conveyor belt for coarse aggregate, 40–120; length 58·6m	1	130
AA	Conveyor belt for sand, 0–3; length 18m	1	78
BB	Conveyor belt for sand, 0–3; length 12·5m	1	78
CC	Conveyor belt for sand, 0–3; length 34·5m	1	78

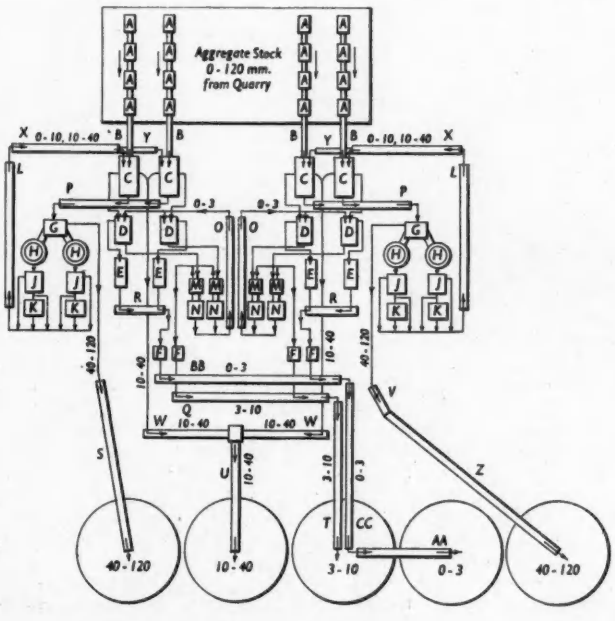


Fig. 10—Flow Diagram of Aggregate Plant

finally washed in the recovery plant (*E* in the legend), from which it is extracted by buckets fixed on a rotating wheel. The final adjustment of sizes, so that the correct proportional quantities of each size (0–3, 3–10, 10–40 and 40–120 in millimetres) are obtained, is made by the secondary crushers and the sand mills. The only time that material has to be elevated is after passing through these mills and crushers, for the tops of the silos for storing the graded aggregates are at about the same level as the lowest installation shown in Figs. 9 and 10. The capacity of each of the five storage hoppers is 4550 cubic yards. Again, the top of the concrete plant is not much higher than the bottom level of these storage hoppers.

Concrete Plant.—The concrete batching and mixing station comprises two similar plants built on a substantial reinforced concrete base and enclosed within a single timber housing (timber structures have been used extensively on the site to house constructional plant). Each plant consists of a storage bin, a group of three 3 cubic yard tilting drum mixers supplied from automatic weigh batchers, and a collecting hopper beneath the mixers. Concrete is discharged from the plant into steel-bodied trucks which carry it along a ramp (marked 14 in Fig. 4 *ante*), where it is tipped into the cableway skips.

Each of the two batching and mixing plants of the concrete station has a peak capacity of 216 cubic yards of mixed concrete an hour, allowing a mixing time of two and a half minutes, and a capacity of 180 cubic yards for a three-minute mix. Each plant comprises a turnhead at the top of the structure ; four aggregate storage compartments immediately beneath it, which are arranged round a central cement storage compartment ; and individual weigh-hoppers positioned beneath the storage hoppers. The weighed materials are discharged into a collecting cone, and thence by a swivel chute into one of the three mixers. Below the mixers there is a 9 cubic yard collecting hopper to receive the mixed concrete, and hold it until the empty truck is in position. This general layout will be clear from reference to Fig. 11.

The supporting structure of the units consists of broad-flanged joists, erected on the site to the makers' design. The turnhead at the top of each plant is manually operated with four fixed guide chutes for charging the four storage compartments, each of 150 cubic yards capacity, of the circular aggregate bin which is 35ft in diameter. Each compartment has an undercut radial gate operated by one or two double-acting pneumatic rams (two for the largest aggregate size ; this gate also has cast iron choker weights to prevent jamming when it is closed), the opened width being adjustable. At the start of weighing the gates are opened wide, to give a fast flow of material, until, at a given " underweight," they open and close rapidly to give a controlled feed for the final weighing. All weighing is automatic, as explained below. A rack-operated gate is also fitted between the feed gate and the storage compartment, to allow inspection of the feed gates when the compartments are full.

The central cement compartment has a capacity of 100 tons. Cement is conveyed to it pneumatically, and there are low-pressure air jets at its neck to prevent arching of the cement at discharge. There is also a high-level indicator. The rotary cement valve controlling this compartment operates in a similar manner to the gates of the aggregate compartments, and there is, as well, a sliding cut-off gate.

The aggregate and cement weigh-hoppers have radial gates and rotary valves, respectively, similar, to the storage hoppers above them. They are of welded construction, with openings for the removal of material for sampling. Sliding doors control these openings on the cement hopper, which also has canvas seals at its discharge opening. A springless pendulum system of weighing is used. The movement comprises a cam and pendulum weight, actuated by a flexible steel band coupled to a lever arm, all designed to give equal divisions on the loading chart. These, with gear-operated pointer and oil dash pot complete the mechanism. The

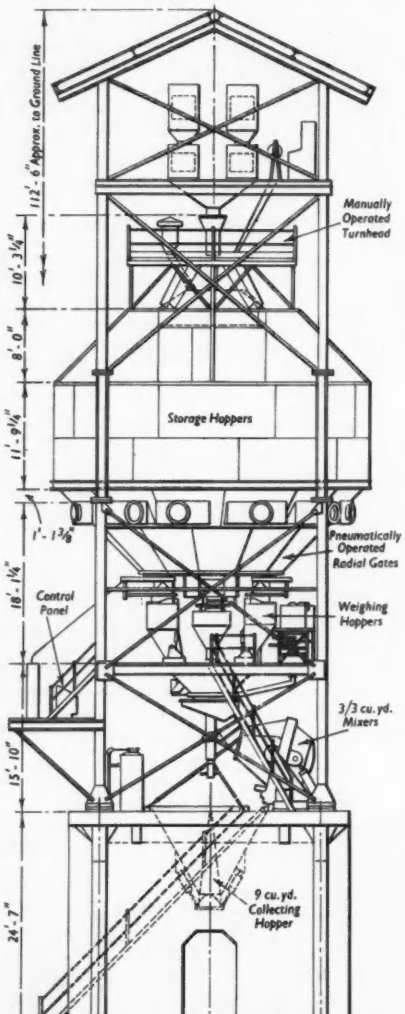


Fig. 11—Cross Section Showing Arrangement of One of the Dual Plants of the Concrete Batching and Mixing Station

weighed materials are discharged into the collecting cone, and are then directed to the appropriate mixer by an electrically operated swivel chute powered by a 1½ h.p. squirrel-cage motor. At this stage water is introduced into the constituents of the mix from a water weigher, the hopper of which is also operated by pneumatic valves ; there is a water channel in the swivel chute, and the chute has a retractable end to give a positive seal with the mouth of the mixer. Each mixer is powered by a 40 h.p., 400V, three-phase, 50 c/s squirrel-cage motor.

One of the most interesting aspects of the design of this plant is the system of automatic control for this somewhat complicated sequence of weighing, discharging and mixing operations. All of these operations, except the filling of the aggregate storage bin from the turnhead, are controlled from a desk and weighing dial cabinet in a control room remote from the weighing room (the control room is, in fact, cantilevered out from the structure at weighing room level as shown in Fig. 11). The electrical interlocks and relays of the control system are all accommodated in the desk, below the operating panel. Operation of a push button on the control desk initiates simultaneous weighing of each material, and discharge from the weigh-hoppers is controlled by a second button. The six weighing dials are linked to an electrical system giving automatic individual closure of the feed gates and valve just below correct weight (as described above) and then intermittent operation until the correct weight is registered on the dial ; correct weight and overweight for each material is also shown by lights on the desk. A moisture compensator, which is set by hand, is incorporated in the fine aggregate weigher. The controls may be set or changed to any of six different concrete mixes, without delaying operation of the plant, and other switches allow the weighing of each material individually if required. There are also switches to control the tilting of the mixers for discharge, and lights indicate when the mixers are in the charging position. Mixer timers are also incorporated in the control panel, giving a mixing time adjustable from 0 to 5 min. Another adjustment allows discharge of the weighed materials in sequence, instead of simultaneously if required.

Electrical interlocks in the control system give the following safeguards :—dry batches cannot be discharged from the weigh-hoppers until all materials are correctly weighed ; the feed gates of the storage hoppers cannot be opened until the discharge gates of the weigh-hoppers are closed ; batches cannot be discharged from the collecting cone until the swivel chute is correctly positioned relative to a mixer in the charging position; and concrete cannot be discharged from a mixer until it has been mixed for the required time shown by the timer on the panel. Recorders in the control panel give a continuous record, on paper, of the weight of each material in every batch. The plant is stated to give an accuracy of ±1 per cent in weighing cement, and ±2 per cent for fine aggregates and ±3 per cent for coarse aggregates. The makers state that it embodies a number of improvements, intended to give consistent accuracy and rapidity of operation, and it is more compact than their previous plants, particularly in the control room arrangement.

Cableways.—As mentioned earlier in this article, the cableways at Grande Dixence dam depart from conventional practice in that the track for the tail carriages is steeply sloped—a requirement forced by the topography of the site. There are four cableways, each spanning 2850ft and carrying a concrete skip of 8 cubic yards capacity. The headmasts are all grouped in a single tower and the tail carriages travel on a track 1000ft long and sloped at 35 per cent. The cableways operate with hoisting speeds of 8·2ft per second, and travelling speeds of 17·2ft per second. The tail carriages can be raised up the incline track at a speed of 10ft per minute.

Plant Layout.—A good idea of the plant installation at the site is given by Figs. 7 and 8. Fig. 7 shows the sloped track for the cableway tail carriages on the left of the illustration, with the gorge forming the actual dam site between it and the rest of the plant. The next building to the right of the gorge is the terminal of the cement ropeways, and the two curved steel structures

forming the end of the ropeways may be observed. Two cement storage silos are just to the right of the ropeway terminal. The large building a little further to the right is the double concrete plant, with covered belt conveyors leading to it from the silos where the graded aggregates are stored. Similar belt conveyors feeding the aggregate silos may also be observed on the right-hand side of the illustration. The building behind the aggregate silos is the winch house for the cableways, and the combined cableway headmast is under construction behind it. One of the load carriages of the cableways may be seen just to the left of the concrete plant. A closer view of the cableway winch house, graded aggregate silos and concrete plant is given in Fig. 8 ; the inclined service railway leading up to the tunnel to Prafleuri passes between the winch house and aggregate silos, and the bottom of it may be observed in Fig. 8 ; the small gantry carries a travelling crane for handling materials on to the railway. The roadway for hauling the concrete skips from the mixers to the cableways had not been completed when the photographic original of Fig. 8 was taken.

As we have already mentioned, the company responsible for the design of the Grande Dixence project is the Grande Dixence S.A. The dam is being built by a company formed specially for that task, namely, Le Consortium du Barrage de La Grande Dixence ; the three parent companies of the consortium are the Grande Dixence S.A.; S.A. Conrad. Zschokke; and Losinger et Cie, S.A.

The constructional plant was supplied as follows :—The primary crushing plant at Prafleuri, by U. Amman S.A., except for the 42in gyratory crusher, which was supplied by Allis-Chalmers ; the aggregate washing, screening and secondary crushing plant was supplied by the Robert Aebi Company (usines Von Roll). The four cableways were designed and manufactured by the Italian firm, Ceretti and Tanfani S.p.A.

British Plant.—Three British firms have contributed their products to this major plant installation at Grande Dixence dam. The excavators employed there were built by Ruston Bucyrus, Ltd.; Pegson, Ltd., supplied the two gyratory crushers of 100 tonnes per hour capacity, which are installed in the Prafleuri tunnel to correct the aggregate grading, and Blaw-Knox, Ltd., designed the concrete batching and mixing station, described in some detail in the preceding columns, and supplied the weighing and control mechanism for it, the structural work being done on site.

(To be continued)

French Locomotive Experiences

By EDWARD H. LIVESAY

(Continued from page 558, April 16th)

No. VII—PARIS/DIJON/BOURG AND RETURN—ELECTRIC AND 2-8-2 MIXED-TRAFFIC STEAM LOCOMOTIVES

WHEN met at the Gare du Lyon, one fine summer morning, by Monsieur Segaud, of the Department of Design, S.N.C.F., to go with him to Bourg on electric and steam locomotives, I did not foresee the extraordinarily interesting day that lay ahead of me, and that my experiences were to be of an entirely novel and outstanding nature. I had never before ridden in the cab of an electric express locomotive—that was the first novelty ; and I certainly did not expect to cover long distances on one at an average speed of 71 m.p.h. while hauling an 800-ton train. Neither had I ridden before on a small-wheeled 2-8-2 steam locomotive, also tied to an 800-ton train, running over a quite difficult route, the track, incidentally, in none too good condition, with the engine ditto, at an average of 50 m.p.h. ; both these fine performances were to be demonstrated, and are certainly worth description. In fact, it turned out to be one of the most intriguing days of the whole unforgettable month spent in France as the guest of the S.N.C.F. Truly, they are doing things in France on the railways that I have never seen equalled anywhere else ; I fear it will be a long time before we see similar work done in Britain. So much as an introduction.

The train on which we travelled to Dijon was the 8.20 a.m. from the Gare du Lyon, and the engine was No. 2D2-9104 (Fig. 38), in the hands of mecanicien Martin, accompanied by inspecteur Paris—at any rate, that is what I find in my notebook, and I suppose it could be !—Monsieur Segaud and myself. The load was a comparatively light one, a mere 540 tons gross ; the 800-ton one was on the return journey. The chief details of the engine are as follows : Built 1950, 1500V d.c., maximum speed 93 m.p.h., tractive effort 40,000 lb, driving wheels 5ft 9in, adhesive weight 81 tons, total weight 142 tons, length 59·4ft, rating, 1 hour, 4880 h.p., 35,000 lb at 52 m.p.h.; rating, continuous, 4400 h.p., 30,500 lb at 54 m.p.h. There are three motors, each of which drives two axles through coupled rear-wheels, with intermediate gear-wheels and flexible couplings. The electro-pneumatic contactors give thirty-two running positions on the controller. The cab fittings were very simple, consisting chiefly of controller, brake, sander, volt-meter, ammeter, hooter and, of course, Flaman recorder. There were seats, of a simple type, but I do not think the driver ever used his—possibly he is not allowed to, as a precaution against going to sleep, which I found very easy to do—mine taking the shape of a very flexible bicycle-saddle, which I, too, preferred generally to ignore. Window-wipers, of course. The controls were arranged on a desk extending across the front of the cab, as on the gas-turbine No. 18100 B.R., and the diesel-electrics. There was not too much room in the cab ; it was very different to the C. and N.W.R. diesel-electric, on which it took the shape of a small room furnished with two padded mahogany revolving club armchairs. They demand luxury in an American cab, and get it.

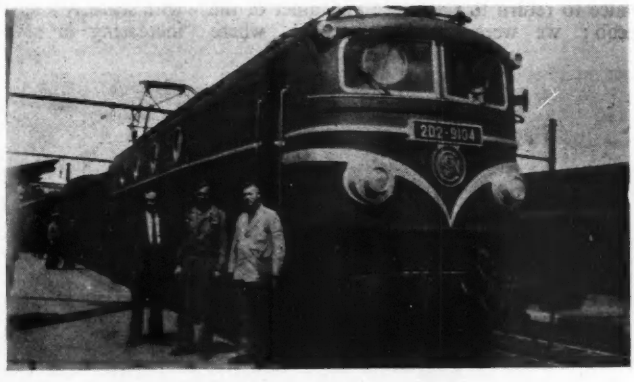


Fig. 38—Electric Locomotive No. 2D2-9104

We left punctually at 8.20 a.m., picking up speed rapidly, reaching 55 m.p.h. within 3 miles, but there were probably restrictions within the city, and the track, though practically level hereabouts, showed considerable curvature, which was taken smoothly, being entered and left with no objection. The riding was very good ; merely a little quick nosing, which I cannot account for, as each of the bogies carried 30 tons. There was no noise in the cab beyond a slight high-pitched singing from the gears and, of course, the "look ahead" was perfect, very different from the restricted view one gets from a small window along the big boiler of a steam locomotive.

At Villeneuve St. Georges, after crossing the Seine, the first incline was struck, extending for 7 miles, mostly 1 in 200 ; in the middle of it, at Brunoy, the speed was 69 m.p.h., 850 amps. This, too, was a new experience ; I do not remember having been on a locomotive doing 69 m.p.h. up 1 in 200 with 540 tons trailing ; but better still was to come before the day was over. Melun, 26 miles in 26 min, even time, 1 min early. The track appeared very good, with crushed rock ballast, and in perfect order ; the signals were automatic colour-light, audibly passed into the cab in the standard S.N.C.F. manner. Fontainebleau, 35½ miles in 34 min ; I could not help noticing the solidity and neatness of the track auxiliaries, such as concrete drainage channels wherever ditches were needed. There was a fine concrete viaduct at St. Mammes, with the Seine (I think) on the left ; the substations, also of concrete, flashed by at intervals of half-a-dozen miles or so ; they have mercury arc rectifiers remotely controlled, and are automatic. Approaching Montereau, we slowed for the first time, by signal, picking up through the station, passed at 9.05 a.m., 1 min early ; 48 miles, 45 min. Evidently the average speed was going to be sixty or more—considerably more, as it turned out.

There had been four tracks all the way from Paris, and traffic seemed fairly heavy, all kinds of trains being noted, steam and electric ; freight trains were very long. Gradients were now almost non-existent ; for 120 miles it was nearly level going (Fig. 39), though with a steady upward trend, very slight, not sufficient to have any effect on a 4880 h.p. engine, and long stretches of straight made the layout ideal for high-speed running. One hour and 64 miles from Paris we swept through Champigny ;

the humming flight would continue uninterruptedly to Laroche, 93 miles from Paris. At Sens we entered wooded, hilly country ; there was a little church perched high on top of a rocky outcrop, a French Brentor ; shortly after running out into open, rolling plains, carpeted with the ever-present wheat, which showed signs of the drought, just as it had done north and west of Paris. The combination of conditions was such as to induce my besetting sin, sleep—the quiet cab, the soothing musical whine of the gears, the crew seldom speaking, long periods of silence prevailing—why should they ; there was nothing to talk about !—the sunny track peeling endlessly away, approaching from infinity and disappearing in a blur of ties underneath ; the landscape, shimmering in a hot golden glow, moving smoothly by on both sides. Yes, the steam locomotive is pretty crude, one could not help realising ; even " U1 " and " P33," good luck go with them ! No wonder the seating in these electrics is not made ultra-luxurious ; it would be too easy, and forgivable, to fall asleep, and so meet disaster.

Leaving Cézy, 84 miles in 79 min, on a short stretch of slightly falling gradient, the speed rose to 81 m.p.h., the fastest noticed so far ; I made a brief visit to the engine-room, finding it very noisy, what with the song of the gears, here more prominent, and the roar of fans and blowers ; it approached the roar in the gas-turbine's engine-room, but did not equal it. It was nice to return to the peace and quiet of the cab ; we were nearing Laroche, where the only stop was made at 9.45 a.m., 2 min early, 93 miles in 85 min, 65 m.p.h.

Due to the early arrival, the scheduled 3 min stop extended to 5 min ; we left at 9.50 a.m. and in a few minutes, at St. Florentin, the quadruple tracks narrowed to two, ours being on the left, as in England. To make full use of these they are reversible ; that is to say, both can be used in either direction, controlled by interlocked signals ; when the traffic is extra heavy trains can run in the same direction on both tracks. Quoting from THE ENGINEER : " Each reversible track is equipped with two automatic blocks, one for each direction. Switches and signals are operated remotely by push buttons on a control panel in the central command post, where a single train dispatcher ' sets up ' the routes as required, making use of an illuminated track diagram. The passage of the train breaks down the route automatically. When reversible running is not required, the train dispatcher can allow both tracks to revert to normal directional running, under automatic block control. A direction interlock prevents the admission of two opposite trains in the same block section. A particular route can be preselected, though part of it may be occupied ; the selection is registered and, later, when the occupied zone is free, the route is established." This reversible stretch extends from St. Florentin to Les Laumes, 44 miles.

A gentle rise begins at Laroche, continuing with scarcely a let-up for 80 miles, constantly increasing in severity, to Blaisy-Bas ; a very fine testing stretch, up which many a fine steam locomotive has showed its potential. It was well-wooded, pretty agricultural country here, this Central Plain of France, as seen this glorious hot summer day. Everybody in the cab seemed at peace with the world, as well they might be ; mecanicien Martin was entirely so, and looked so youthful to be handling this fast train, say, 20/25, that I was tempted to tactfully enquire his age—it was 38 ! I must be really getting old ; to me this middle-aged man looked a mere youth.

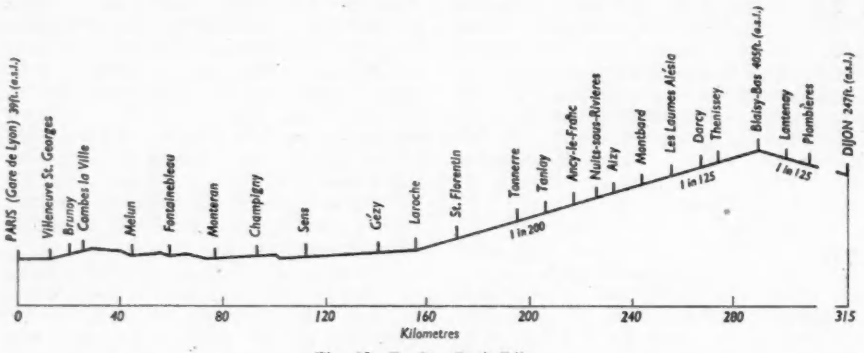


Fig. 39—Profile, Paris-Dijon

Tonnerre, 118 miles, 113 min, 1 min early. Many track gangs were noticed at work, more, I think, than in Britain. All the civil engineering seemed very good ; the track well-cared for, stone, concrete or steel bridges, no sign anywhere of neglect or shortness of labour. The whole stretch from Paris looked ideal for high-speed running, and it is not a matter for surprise that some of the fastest traffic in Europe is now found upon it.

There is very little to note in the cab of an electric locomotive. Some representative figures of current at different points are here given ; all were taken on up-gradients of 1 in 200, except nearing Blaisy-Bas, which was on 1 in 125 ; at Les Laumes the engine was accelerating after coming off the two-track stretch.

	Current (Amperes)	Speed (km)
Montbard	300	110
Les Laumes Alesia	500	110
Darcey	300	105
Thenissey	300	110
Blaisy-Bas	375	90

Blaisy-Bas was passed at 11·6 a.m. O.T. ; 179 miles in 166 min, 64·7 m.p.h. This is the summit of the long rise from Paris, which had raised the train from 39ft above sea level to 405ft above sea level ; immediately after, we entered a long 2-mile tunnel on a down gradient of 1 in 250 ; it was taken at speed, controlled by signals that are placed at intervals throughout. It was all steeply down to Dijon, much at 1 in 125, taken at speeds up to 72 m.p.h. ; the ammeter needle was right back to zero. I do not know whether regenerative braking is used, forgetting to enquire. Very rocky country here, quite different to that on the north of Blaisy-Bas. Nearing Lantenay there were some deep retaining walls needing considerable repair, which

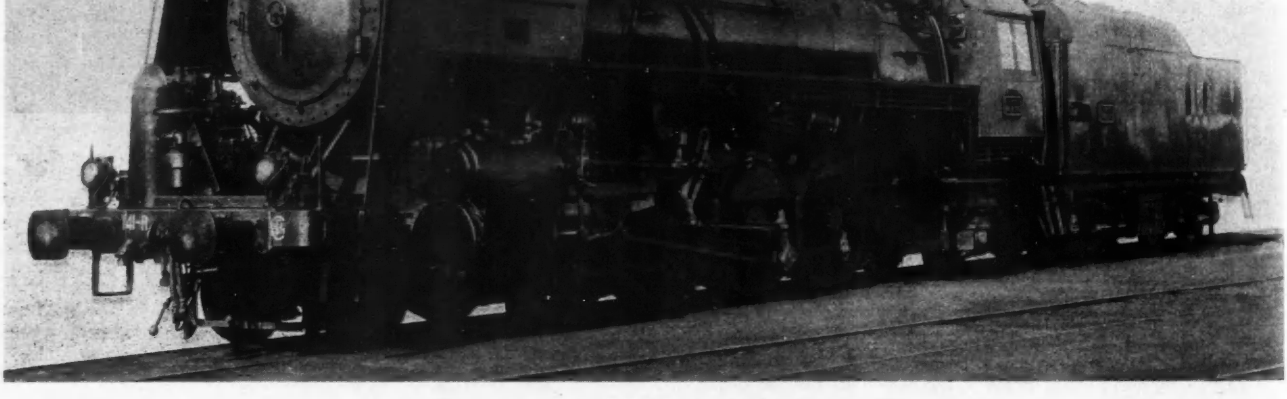


Fig. 40—Two-Cylinder 2-8-2 American Freight Locomotive

was being done. A brief stop outside Dijon, then to a final stand in the station at 11.22 a.m.—of course, 1 min early! 195 miles in 182 min, with one stop of 5 min included; average speed 64·3 m.p.h. I was told another train had followed right from Paris 3 min behind. A very fine and interesting trip, high-lighted by consistently fast running, and the most perfect adherence to schedule imaginable. At every point throughout the train was invariably O.T. or 1 or 2 min ahead.

It should be emphasised that this was not a very fast train, as they go between Paris and Dijon. The "Mistral" is only allowed 152 min for the 195 miles, an average of 77 m.p.h., and train No. 16, northbound, 155 min, 75·6 m.p.h. However, the reader must not be disappointed; better things will be recorded on the return journey, with 800 tons trailing.

Our trip to Dijon and Bourg—Monsieur Segaud's and mine—had been taken not merely to enable me to report on the running of the electric trains, but to ride on one of the American-built 2–8–2 mixed-traffic engines which had been fitted with a new type of oil-firing apparatus designed by Monsieur Segaud himself, which was doing very good work. Unfortunately, as it turned out, much to Monsieur Segaud's disappointment, and mine, the apparatus on this particular engine this day was not at all in "good nick," a certain small but vital part not being in position. But this in one way made the trip from Dijon to Bourg all the more interesting, as despite the defective working of the firing system the engine did a spectacular performance, one as new to me as the electric locomotive's had been. My sole complaint was the way it was done! But I anticipate: all will be revealed in due course.

Figs. 40 and 41 illustrate this type of engine, a 2–8–2 American machine, built—or "outshopped" as they say in the States—in 1945. There are 1200 of these general purpose machines running in France, as maids-of-all-work; they are referred to in S.N.C.F. circles as "the chain-gang," which is really complimentary. All kinds of rough and rugged work gets handed over to these rough and rugged machines, and judging from my experience of the class, I have no doubt they do it uncomplainingly. But how! Again I anticipate.

The principal dimensions and details of these engines are :—

Steam pressure	228 lb.
Cylinders (2)	23·9in by 28·4in
Boiler, diameter, inside	6ft
Boiler, length between tube-plates	17ft
Grate area	56 square feet
Heating surface :	
Large tubes (36)	868 square feet
Small tubes (175)	1568 square feet
Firebox (2 siphons)	298 square feet
Superheater (Schmidt)	713 square feet
Total	3447 square feet
Oil-fired on Segaud system; one burner in front; air entering only round burner; lower part of walls and bottom brick-lined; no brick arch.	
Wheels :	
Leading truck, diameter	3ft ½in
Driving, diameter	5ft 6in
Trailing truck, diameter	3ft 6½in
Weight :	
On leading truck	16·5 tons
On driving (each axle)	20 tons
On trailing truck	19·7 tons
On total	116·2 tons
Valves (piston, Walschaert) :	
Diameter	12·2in
Travel	6·8in
Maximum cut-off	85 per cent
Minimum cut-off	8·5 per cent
Tractive effort	53,240 lb
Factor of adhesion	3·3
Speed limit	55 m.p.h.
Worthington feed-pump and heater	
One l.s. injector	
Multiple-valve regulator	
Kylchap blast-pipe	
Power-operated reverse	
Franklin auto-adjusting axlebox wedges	
Timken roller bearings all wheels	
Westinghouse compound pump	
Electric lighting	
Flaman recorder	

The route to Bourg over which this run took place from Dijon, continues through Amberieu, Aix-les-Bains and Chambery to the frontier station of Modane. As the profile shows (Fig. 42), the first part is easy enough, but the last 80km are very hard, with incessant fluctuations, many as steep as 1 in 125, and some 1 in 100. It runs due south from Dijon and is near the frontier, with Geneva not far away to the east, and the Alps in sight.

The train was the 11.50 a.m. ex-Dijon, consisting of seventeen coaches and a van, weighing well over 800-tons gross; the engine was No. 141-R1114, in charge of

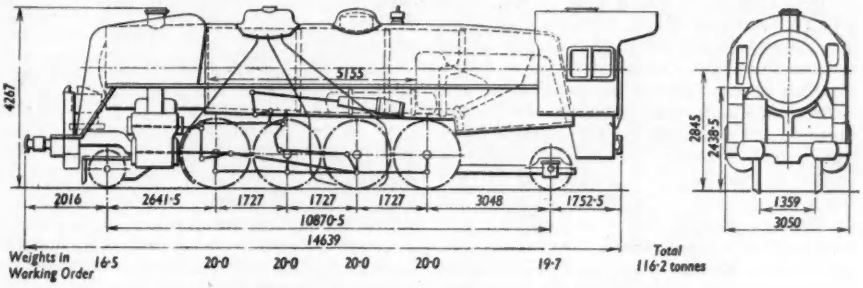


Fig. 41—Leading Dimensions and Weights of 2-8-2 Locomotive

mecanicien Rossé and chauffeur Susky; with Monsieur Segaud, two *inspecteurs* and myself, there were six persons in the cab. We got under way punctually; the gradient immediately outside the station being descending, and the engine having 80 tons on the drivers, acceleration was rapid, without slipping. The cab fittings were essentially American, save that things were arranged for left-hand drive, a concomitant of French left-hand running. The regulator was of the standard American hanging type, and seats of the round, backless "snack-bar" pattern were provided. The Segaud burner has five jets in the oil/steam atomiser, with the air inlet reduced in size to increase velocity, but I need say little about it here in view of its bad behaviour, as I hope to travel later on an engine provided with an example of it in proper kilter.

Immediately we got going and long before the engine had reached its permitted maximum speed, I guessed that a rough trip lay ahead. Its action was hard and harsh to a degree, completely different from the light, springy feel of the well-balanced, multi-cylindered engines I had been riding

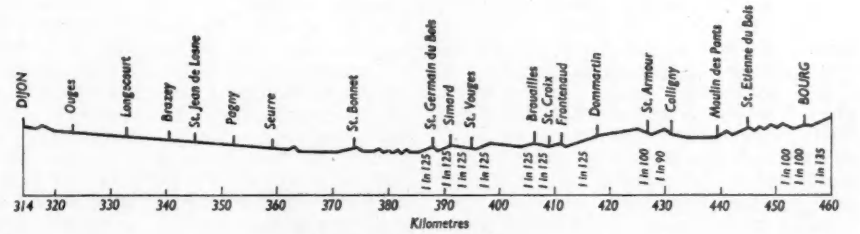


Fig. 42—Profile, Dijon/Bourg

previously. No doubt the action seemed all the worse as I had come down from Paris on an electric machine, which made the contrast all the more shattering. Moreover, piling Pelion upon Ossa, the oil-firing apparatus was not working well; despite all that Monsieur Segaud and the fireman could do to get the proper ratio of oil to air, there were frequent muffled explosions in the firebox, with flame flashing out round the rim of the firedoor, and excessive smoke from the chimney. The mixture was evidently too rich; Monsieur Segaud was very disappointed that the fruit of his loins should be showing faults, and at having brought me so far to demonstrate a device not on its best behaviour. I assured him he need not be in the least concerned, as the whole day was turning out extraordinarily interesting, and I would not have missed it for anything. Besides, the fact that the firing apparatus was faulty only made the performance of the engine the more striking, because it was doing really fine work, of a kind I had never experienced before, and worth recording.

From the profile it will be seen that the first part of the route, as far as St. Bonnet, was quite easy, mostly descending and level, but that then it stiffened and the farther south we went the harder it became. Yet, whatever the conditions, uphill, downhill or on the infrequent level, the speed seldom seemed to fall below the engine's permitted maximum of 55 m.p.h., despite the heavy 800-ton load. It was thrashed; no mercy was shown it—and in turn it showed us none! The riding was simply damnable, the engine doing everything a well-behaved engine should not do—it rolled, nosed and pitched, roaring hoarsely, and the footplate vibrated so violently it was like riding on an angry pneumatic riveter. The heat radiating from the back plate, which included a red-hot firedoor, added to my sufferings, and before we were halfway to Bourg I began to pray for arrival, and wonder if I could last out until we got there. Staggering from an unusually vicious lurch, I caught the eye of one of the inspectors; he smiled, and shrugged his shoulders, shouting above the din: "Americaine!" I yelled back "Oui—trés Americaine!" It was the *entente cordiale* in operation—we suffered together, and would have mingled our tears, too, no doubt, had they not been so superheated by the red-hot fire-door that they evaporated before even reaching our cheeks. Yet all this turmoil could not blind me to the very fine work the engine was doing under difficulties; though limited to 55 m.p.h., it was averaging 50 m.p.h. and keeping to the working schedule with wonderful accuracy, as at every passing point the train was either on time or a trifle ahead. In justice to the engine, too, I must add that I was told the track was not in good shape and was to undergo extensive relaying

shortly. In fact, everything was against a good performance, yet one was being achieved.

At speed, the regulator was kept full open and the cut-off about 15 per cent. I exclaimed at this but was assured the scale was correct—it was a temporary one, marked in chalk. My notes say 100km was touched more than once, which, of course, is 62 m.p.h. ; if so, evidently the limitation was not being strictly observed, which was strange, as I had always noticed how meticulously rules and regulations were adhered to on the S.N.C.F. Passing St. Bonnet, we were apparently 4 min ahead of time and I had understood that in France trains are not allowed to run more than 3 min early. The engine was being extended, though whether to the limit I do not know—my temper and endurance certainly were. On occasion, in Canada, I have abandoned a cab because I would not stand a bucketing engine any longer ; I wanted to do the same thing once in Scotland when I had accidentally strayed on to a " Shire," but was prevented from doing so because the train made no stop short of the terminus. I really think I should have been justified in abandoning ship this time, but could not, as this train, too, was non-stop to Bourg. My notes say : " One of the worst-riding engines was ever on—maybe *the* worst." It was certainly a brute !

During the later stage of the run the flashing-back into the cab became less frequent and combustion somewhat better ; there was less smoke from the chimney and only an occasional puff from round the firedoor. When oil-firing apparatus is in good order, the system is almost perfect, with freedom from smoke and smell ; coal-firing is far more productive of both. I do not think many engineers would bother with coal if oil were obtainable.

The engine was doing very fine work on the heavy gradients nearing Bourg. Between Dommartin and St. Armour, on 1 in 200, the speed was 45 m.p.h., with cut-off 10/15 per cent ; down 1 in 85 to Collingy, the Flaman registered 54 m.p.h., and nearing St. Etienne, on 1 in 100 down, apparently to get a flying start for a mile of similar inclination up to that village, I have 100km in my notes. On this steep climb the cut-off was 30 per cent, full regulator, the speed never falling below 40 m.p.h. This, with 800 tons trailing—No. 141-R1114 was indeed doing good work.

The cut-off did seem extraordinarily short at times and I enquired about it. At one point I was told it was 5 per cent, which was incredible ; it seems even more so now I have studied the official figures, which give 8·5 per cent as the permissible minimum! My expression may have led the inspector to try and underline the engine's wonders, as shortly after, he pointed to the cut-off scale, making a 0 with his thumb and forefinger—I really couldn't swallow this ! Even if the reverse had been in mid-gear the valve-travel wouldn't have been zero, the gear being Walschaerts, with constant lap-and-lead taken from the cross head. I don't quite know what he meant ; this was one instance where lack of French tripped me, and I was left groping. I remind the reader the scale was in chalk.

Nearing Bourg, the track was welded, but though the noise was less, the violence of the engine's convulsive plunges remained much the same. I was still praying we might get to our destination, and breathed a deep sigh of relief when the engine came to a stand in the station at 1.35 p.m., 2 min early ; 85 miles in 104 min, 49 m.p.h. A really fine performance by that small-wheeled engine over a heavy route with an 800-ton load—but how glad I was the trip was finished! The prospect of a wash and one of those delightful French lunches, with Monsieur Segaud and another official, added to the joy of realisation that the tumult and the shouting were things of the past. The gastronomic interlude extended to nearly two hours, until there was only just time to catch a train back to Dijon at, I think, 4.22 p.m. Pages of my note book that should have recorded happenings on the return from Bourg are of virgin purity ; as a matter of fact, I travelled in the train with Monsieur Segaud and we both slept peacefully the whole way.

From Dijon back to Paris the same electrified route as in the morning was to be taken and the train, headed by engine 2D2–1903, weighing over 800 tons, pulled out at 6.34 p.m., 5 min late, with mecanicien Tapin and chauffeur Dedalin in charge, Monsieur Segaud laughingly deserting us for the comfort of a coach ; I could not blame him, but duty forbade my doing the same thing. Immediately clear of the platform a heavy gradient begins, continuing for 16 miles to Blaisy-Bas, on which the ammeter registered 750/800A ; passing Plombières, on a brief level piece through the station, the brakes were tested. At first I declined Dedalin's seat, fearing it would make me sleepier than ever, but soon succumbed to the seduction of the motor-cycle type saddle—the combined effect of the wracking trip to Bourg and the two-hour lunch had begun to tell. This is called Nemesis, I believe. Nearing Lantenay, on 1 in 125, 750A were called for at 68 m.p.h., which speed was kept up all the way to Blaisy-Bas, passed at 6.50 p.m. ; 16 miles, which had raised the train 158ft in 16 min. The 2-mile tunnel nearing Blaisy-Bas was negotiated at the same speed ; it is dead straight, the exit being visible immediately on entering, brilliant colour-light signals punctuating the clean, cool, blackness. At Thenissey, drifting with ammeter reading zero, and speed 77, the riding was very good, the engine almost bouncing on the rails, feeling light, springy, but the tell-tale notes say : "... falls short of C. and N.W.R. (diesel-electric) perfection." At Darcy we were doing over 80 m.p.h. ; noted : " there seems more bouncing than in morning, but it is of rubber-ball type, not the abominable wracking, hammering, vibrating turmoil of the 'Americaine' 2–8–2." The only fly in the ointment was the sun, which shone right into my eyes, it's dazzle increasing the tendency to fall asleep. At Montbard 3 min had been picked up since leaving Dijon, but they were soon lost again when a bridge-repair restriction brought the speed down to 10 m.p.h. The track was only double now, and at Aizy the train plunged into the cool shade of cuttings and hills on the left ; it was pleasant to get clear of the level glare of the evening sun, and sweep along at 80 m.p.h., but at Ancy-le-Franc we were still 5 min late, due to the bridge restriction.

At Tanlay, 7.34 p.m., the indicator said 84 m.p.h., a trifle late, but picking up ; it was quite delightful, this smooth, humming flight through the cool evening, after the baking hot day—almost a bouncing flight, if the adjective can be applied to a 142-ton engine. To my surprise, a man " brought up on steam," I found myself enthusing over this soulless mass of metal, which only came to life when its pantograph made contact with a copper wire. Yet it did rouse me, I admit—I seemed to *feel* the power pouring through me, and the engine certainly felt it, too, as it bounced buoyantly along the shining ribbons of steel, and I felt buoyant in sympathy. For the time being the mass of inert mechanism had been galvanised into action, yet I could not overlook the fact that it was not a locomotive as a steam man pictures one—it was only a transmitter of power after all—it had none of its own, of divine right. There was no soul ! " U1 " has a soul, I am sure—and " P33 "—I am less positive about No. 141-R1114, which had plenty of " guts," but soul—I doubt it ! The stark nakedness of the cab of an electric locomotive takes getting used to as well ; everything was so simple and monotonous ; only the Flaman, an ammeter and a volt-meter to watch—and the latter was always 1500V ! I was sorely tempted to deliberately go to sleep, after telling Dedalin to wake me up when we reached Paris.

Sleepers were burning near Laroche, from cinders dropped by real locomotives provided with fireboxes—and souls. I had noticed this on several runs ; it showed how prevalent the drought had been over sunny France. The train came to a stand in Laroche, the only stop and halfway point from Dijon, at 7.58 p.m. ; 99 miles in 84 min, average speed 70.7 m.p.h. This, too, was a new experience—I had never before averaged over 70 m.p.h. for 99 miles. We left again at 8 p.m., with 155km to go ; on a slight declivity and accelerating fast, the amps. were 500, and the speed soon rose to the normal 80 m.p.h. or over ; for the remaining 50 miles there would be no gradients worth mentioning, The intrusive setting sun, a golden ball nearly touching the horizon, with its blinding dazzle, would not bother us much longer ; at Cézy it finally disappeared, leaving only a rosy glow in a turquoise sky to mark the end of a glorious summer day. As is apt to be the case with non-steam locomotives, the speed was deceptive ; when it had seemed to drop considerably, the Flaman would show that actually the fall had only been, say, from 135km to 120km. At Sens, 8.24 p.m., the train was on time again at last ; there were long straights hereabouts, the four-track rails seeming to stretch ahead to infinity, caged in by the overhead equipment. Dusk was falling, and the colour-light signals began to show up brilliantly—extra-brilliantly, as even in daylight they are always very clear. At Montereau we switched from the inner left pair of metals to the outer by a " fly-over " ; shortly after, the right-hand pair swung off to the right and disappeared. There was a good deal of extra traffic this day, at the beginning of " The People's Holiday," all southbound trains being packed with passengers leaving Paris, which we were nearing. Cautious approach brought the train to a final stand in the Gare du Lyon at 9.27 p.m., dead on time; again I wondered whether French trains are ever late ? Laroche/Paris, 96 miles in 87 min, 66·2 m.p.h. ; Dijon/Paris, 195 miles, with one stop, in 171 min, 68·4 m.p.h. A very interesting day was over, during which I had covered nearly 500 miles, mostly in the cab ; one of the most novel of all the many I spent in France. Electric traction certainly has its good features, at any rate, from a passenger's point of view—speed, cleanliness, perfect time-keeping, all seem part and parcel of it. An observer's reaction, however, is naturally different, especially if he has been " brought up on steam." It is less interesting, as there is so little to watch, and once the novelty wears off there is nothing much left.

(*To be continued*)

New Kearny Power Station in New Jersey

(By Our American Correspondent)

No. III—(*Concluded from page 561, April 16th*)

The new Kearny generating station of the Public Service Electric and Gas Company at Kearny, New Jersey, which went into full operation at the end of 1953, constitutes a good example of the most advanced current American power station practice. It employs steam conditions of 2350 lb per square inch gauge pressure, 1100 deg. Fah. initial temperature and 1050 deg. Fah. reheat temperature, and its two sets have a net heat rate of 8920 B.Th.U. per kilowatt-hour. The station comprises two semi-outdoor, two-drum water-tube boilers employing the controlled circulation principle and two 145MW tandem-compound, triple-flow reheat turbines operating at a speed of 3600 r.p.m. The two main alternators are hydrogen-cooled, two-pole machines generating three-phase alternating current at 20kV and 60 c/s.

Boiler Plant

BOTH boilers at Kearny are two-drum, water-tube Combustion Engineering units, Fig. 6, equipped with completely water-cooled furnace walls and continuously slagging bottoms. They are suitable for either pressurised or suction furnace operation and are arranged for tilting, tangential corner firing. In each boiler there are thirty-two coal burners situated at two levels and twenty-four oil burners at a third level. Each of the twin furnaces is about 20ft square, and the dividing water wall has large openings to equalise the furnace pressure.

The high-temperature stage of the superheater, which is situated at the exit of the furnace, has its pendant tubes arranged in platens widely spaced to take advantage of radiant heat and to reduce fouling. The convection reheater, which also has pendant tubes but is without a platen arrangement, follows the high-temperature superheater in the gas path. In the downward pass the gases flow over the three sections of horizontal tubes of the primary superheater, then the continuous-tube, counterflow economiser, and finally the two Ljungstrom air heaters. The latter units each have an effective heating surface of 67,500 square feet. At this point the flow splits as it enters the two decks of the flue dust collectors, which are of the combined mechanical-electrostatic design. The boilers normally operate as pressurised units, using only the forced draught fans. However, induced draught fans have been provided to permit suction firing in case of emergency.

The two gas recirculation fans per boiler take part of the relatively cool flue gases leaving the economiser and deliver it to furnace ports situated between the middle and the lower levels of burners. The control obtained by this gas recirculation makes it possible to maintain the rated steam temperature with a lower furnace temperature when burning coal, thus minimising slagging. These fans also perform the important function of making it possible to attain the rated steam temperature when burning oil. Spray desuperheating is also provided in both the superheater and the reheater to obtain additional steam temperature control.

In addition to its use of pressurised firing, twin furnaces, flue gas recirculation and high steam pressures and temperatures, the steam generating plant of the new Kearny power station is of particular interest as the latest example of "controlled circulation" boilers in America.

Each unit has a continuous capacity of 955,000 lb of steam per hour at a pressure of 2350 lb per square inch gauge. The primary steam temperature is 1100 deg. Fah. and the reheat temperature is 1050 deg. Fah. In the design of this boiler plant use was made of an improved arrangement of downtake piping, pumps and valves. Water is supplied to the common downtake header through four pipes connected to the bottom of the upper drum. Three circulating pumps are mounted on the downtake header through the pump intake, which is situated at the bottom. The discharge lines from all three pumps connect to the lower drum. All water wall and furnace floor tubes connect directly to this drum without the use of any intermediate headers, and all the control orifices are also situated in this drum. In this manner, piping and expansion loops are avoided, since the pumps are not attached to the building structure. Each pump is equipped with a motor-operated inlet valve. Normally, two pumps are in operation and a third one is available for standby duty.

The steam drum design adopted for the current installation consists of a steam-water mixture collecting compartment formed by internal baffles, with turbo-steam separators uniformly spaced and mounted on the collecting box or compartment. It employs a symmetrical arrangement in which there are two rows of turbo-separators with a common internal baffle, and a collecting box on either side of the drum, as shown in the accompanying illustration, Fig. 7. The steam-water mixture enters the top of the drum through nozzles discharging into an annular space formed by internal baffles. The flow of the mixture is directed downward behind symmetrical baffles around the entire drum surface maintaining a uniform drum wall temperature, and then into the turbo-separators. The latter contain a centre core and vanes, which gives the mixture a spinning or centrifugal motion, thereby throwing the water to the outer edge of the inner tube. Directly above the directional vanes and cores there is a skim-off lip, which directs the water over the top of the inner tube and thence through the annular space to the drum. This is the primary separation stage. The relatively dry steam then passes through two opposed banks of closely spaced corrugated plates, which changes the direction of the steam many times and throws out much of the remaining water. This is the secondary separation stage. The third and final stage of purification is accomplished in the screen dryer.

Controlled circulation has depended largely on the development of satisfactory circulating pumps. These pumps raise the pressure of the water from the drum by about 40 lb per square inch. This rise in pressure is sufficient to overcome the resistance of the orifices and the circuit proper. The distribution of the water is controlled by the selection of appropriate orifice sizes in accordance with calculated requirements. At the Kearny station each boiler is equipped with three vertical, centrifugal single-stage, circulating pumps, Fig. 9. Each of the pumps has a 40 lb per square inch differential head

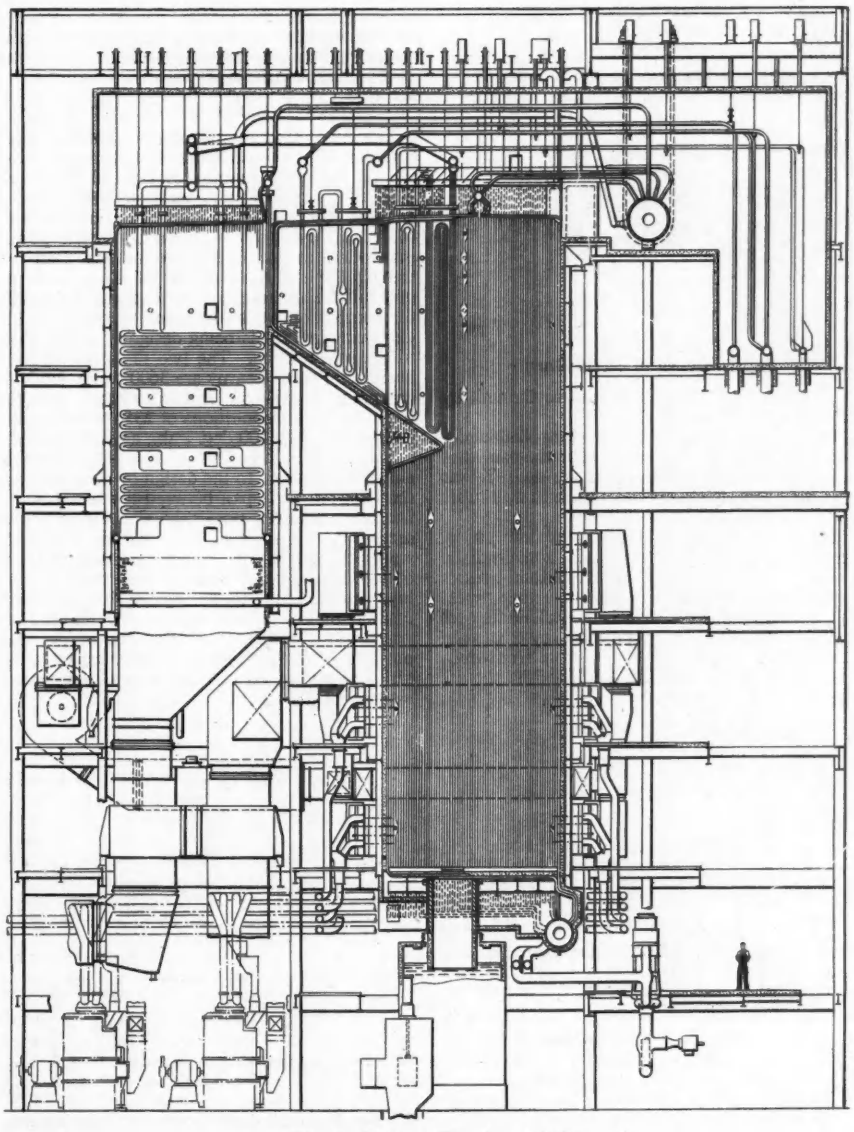


Fig. 6—Sectional Elevation of Boiler

rating at a flow of 7300 U.S. gallons per unit, and two of the pumps are required for full-load operation of each boiler.

Owing to the importance of water circulation at all times, definite steps have been taken to protect the boiler system in case of failure of a pump. An interlock manometer arrangement is connected across the suction and discharge headers of the pumps. The manometer has a magnetic float, which rises and falls with the differential pressure across the headers. Attached to the manometer are mercury switches, actuated by permanent magnets, which are drawn in as the float rises. There are three of these switches, which are set at low, medium and high-pressure differentials. These switches operate lights on the station control board. When all three are lit there is over 40 lb per square inch differential between the headers. This indicates that there are three pumps in service. When two lights are lit there is about 20 lb per square inch differential, which is that developed by two pumps. When only one light is lit there is about 8 lb per square inch differential, indicating that only one pump is running, and an alarm is sounded so that the load will be reduced manually to approximately 60 per cent. Actually, the one pump will circulate sufficient water at normal loads to prevent damage to the boiler for a short period of time. When no lights are lit no pumps

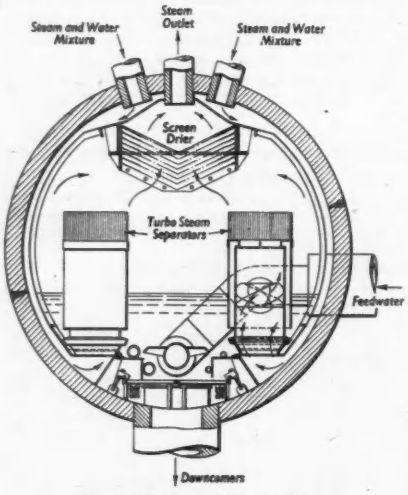


Fig. 7—Design of Steam Drum

are running and all fuel is cut off to the unit by an automatic firing relay.

Because of the positive and controlled circulation of water in the boilers and the fact that relatively low circulation ratios are used, it was possible to use relatively small furnace wall tubes of 1½in and 1⅝in O.D. at Kearny.

Furthermore, since thin tubes are used, the temperature of the tube wall is maintained low and, as a result, the thermal and total stresses in the tubes are smaller. An interesting aspect of the installation at Kearny is the welded furnace wall construction made possible by the even temperature in the walls resulting from controlled circulation and also facilitated by the use of small-diameter furnace wall tubes. To obtain a gas leak tightness of the pressurised furnace the pressure barrier is placed at the water wall tubes, each of which is welded to a bar spacer placed between adjacent tubes. Most of the joining for this construction was done in the shop, and the water walls were shipped to the site in panels ranging in width from fifteen to twenty-four tubes, and in length from 24ft to 49ft. This method of design avoids the necessity of constructing the furnace casing to be leak-tight and has also resulted in a saving in the erection cost of the water walls.

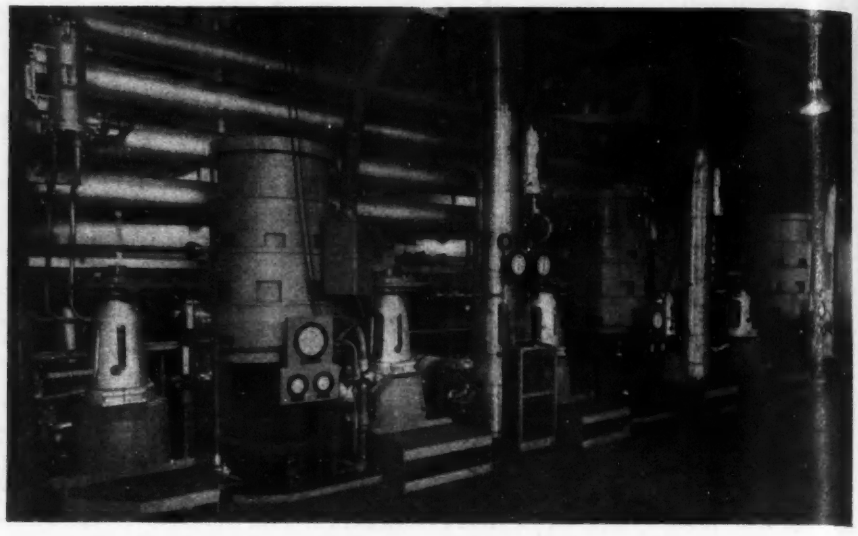


Fig. 9—Boiler Circulating Pumps

Steam Turbines and Generators

The two General Electric 145MW reheat turbines, Fig. 8, installed at the Kearny station are of particular interest because of their size and the high steam conditions which they employ. Since 1948 the growth in popularity of the reheat cycle for steam turbo-electric power generation in the United States has been extremely rapid. As a matter of interest 92 per cent of the turbo-generator capacity scheduled for completion by the Americal General Electric Company in 1954 is being designed on the basis of the reheat cycle. The two units, which have been installed at Kearny are 3600 r.p.m. tandem-compound triple-flow reheat turbines, designed for initial steam conditions of 2350 lb per square inch gauge and 1100 deg. Fah., a 1050 deg. Fah. reheat temperature and a 1½in Hg. absolute exhaust pressure. In the design of these turbines the high-pressure span between the No. 1 and 2 bearings includes not only the high-pressure section of the turbine, but also the first three stages following the reheat admission. The opposed-flow arrangement used confines the high temperatures to a single, relatively short, portion of the turbine and greatly reduces the temperature gradients across the thick wall portions of the high-pressure inner casing. The turbines employ an external control valve chest because of the necessity of using austenitic steel at a temperature of 1100 deg. Fah. Six pipes connect the external control valve chest with the first-stage admissions; two entering the upper half of the casing and four entering the lower half. The steam entering the first-stage nozzle expands toward the front end and returns to the reheater. The reheated steam passes through external strainer casings and then through four pipes to the reheat admission which is situated adjacent to the main steam inlets. Because of the high reheat temperature of 1050 deg. Fah. double shell construction is used at the reheat point as well as at the main steam inlet. After expanding through the first three stages following the reheat admission, the steam passes through the two "cross-under" pipes to the two intercept valves mounted on the upper half of the intermediate casing and then expands through seven single-flow stages to the triple-flow low-pressure section. Approximately one-third of the flow expands through the single-flow portion of the low-pressure section which is contained on the rotor span between the No. 3 and No. 4 bearings and the remaining two-thirds passes through an internal cross-over passage to the double-flow portion.

Each of the two halves of the high-pressure outer casing are machined from a single casting, whereas the inner casing is made of three sections. The central, high-temperature section is machined from an austenitic steel forging with two cast ferritic steel inner casings dovetailed to it to form the inner casing unit. Each of the three sections of the inner casing is individually supported in the outer casing in the horizontal plane and keyed in the vertical plane. With this arrangement, they are free to expand relative to the outer shell and at the same time remain concentric with it. The opposed-flow arrangement confines the high temperatures to the central portion of the high-pressure turbine, and, therefore, the end shaft bearings operate at only moderate temperatures. The intercept

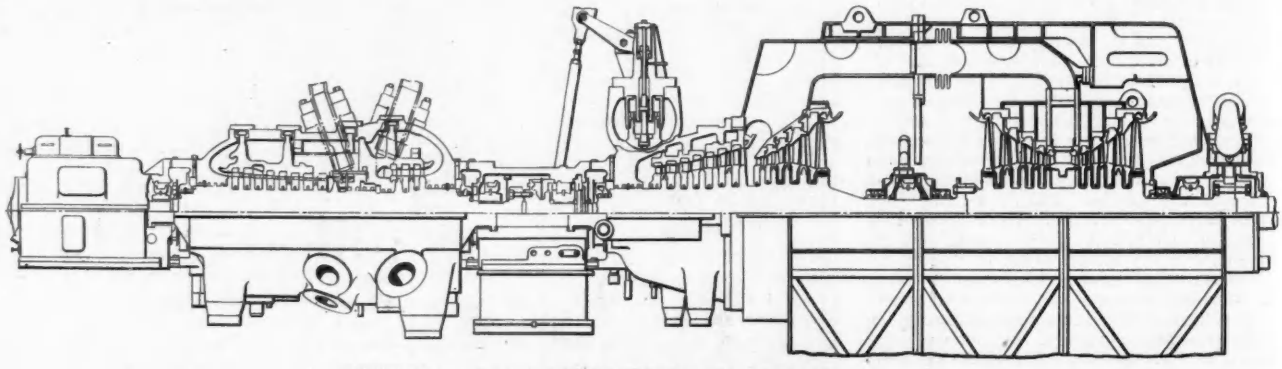


Fig. 8—Longitudinal Section of Steam Turbine

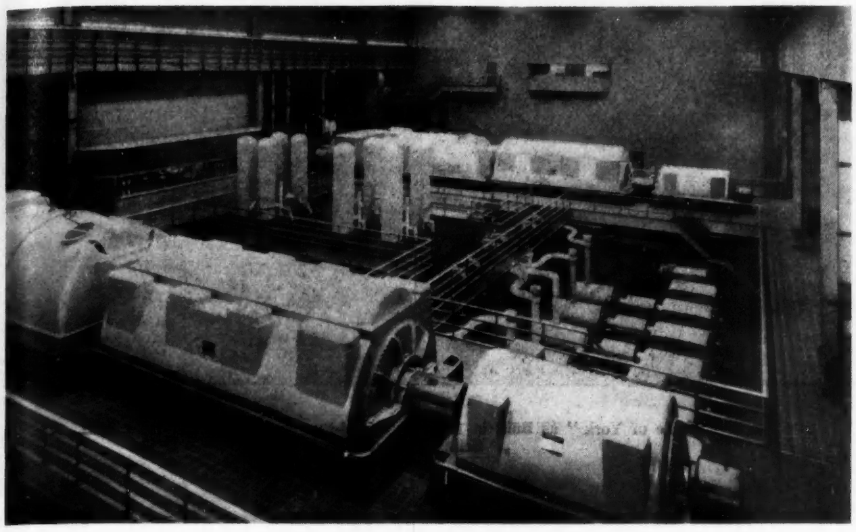


Fig. 10—Interior View of Turbine Room

valves are situated three stages downstream from the reheat admission and hence operate at lower temperatures. This arrangement permits the use of single-shell construction in the intermediate casing. The exhaust casing design is unusual because of the two side outlet exhaust openings being situated below the operating floor level. The exhaust hood structure is supported on the four corners and the loads of the stationary parts and of the rotor are carried to these corner supports through a bridge truss which spans the 17ft 10in long exhaust openings.

The turbine rotor system consists of three separate shaft sections solidly coupled together with a total of six journal bearings. The thrust bearing is situated at the No. 3 bearing. This thrust bearing position minimises the distance from it to the farthest last-stage bucket and reduces the differential expansion. For purposes of dismantling, the high-pressure span is handled separately while the intermediate and low-pressure sections are handled as a unit. A movable internal disc and shim plates at the coupling between the high-pressure and the intermediate-pressure rotors permits the convenient lifting of either section of the rotor.

The cam-operated control valves of the turbine are actuated by a horizontal hydraulic cylinder acting through a rack and pinion and a flexible torsion drive to the camshaft. The six inlet pipes connect the individual control valves to the corresponding admission ports of the first-stage nozzle. The reheat strainer casings are situated in front of the turbine near the control valve chest. These strainers are designed so that blanks may be inserted to permit the pressure testing of the reheater and the reheat piping. Each of the two intercept valves are individually operated by hydraulic cylinders.

In the design of the turbine a serious attempt was made to minimise the use of austenitic materials. The use of a reduced diameter on the first stage reduced the rotor stresses sufficiently to permit the use of a ferritic high-pressure rotor. The three-section, high-pressure inner casing design adopted reduced the amount of austenitic material used at this point. None-theless, a considerable quantity of type 347 austenitic steel (a columbium-stabilised stainless steel having the following chemical composition :— 0·08 per cent maximum carbon ; 2·00 per per cent maximum manganese ; 1·00 per cent maximum silicon ; 9·00 to 12·00 per cent nickel, and 17·00 to 19·00 per cent chromium), was necessary due to the high initial steam temperature of 1100 deg. Fah. The emergency stop valves, the external control valve chest, the control valve stands, the six main steam inlet pipes and expansion joints, the centre section of the inner casing, the first-stage nozzle, and the second-stage diaphragm were all made of austenitic steel. Prior to the manufacture and installation of the turbine units, the General Electric Company participated in a co-operative research effort sponsored by the Public Service Electric and Gas Company aimed at the restriction of the formation of sigma phase in welds in austenitic steel operating at the higher steam temperatures. As the result of this work, a major modification of welding procedures was evolved. In the past, it has been the generally accepted practice in America to utilise welding electrodes containing a substantial amount of ferrite, based on experience indicating that the ferrite was needed to obtain a sound weld. After long-term high-temperature operation, however, the ferrite converted to the sigma phase, resulting in a hard, brittle weld. It has now been learned that sound welds in austenitic steel could be obtained using an electrode with much lower ferrite content and with a carefully balanced composition. It has also been learned that the formation of sigma phase can be further minimised by using a post-weld treatment of 1950 deg. Fah. This post - war treatment differs from those previously used by deliberately going to temperatures above the sigma-forming range, and by going through the sigma-forming range as rapidly as is practicable.

Each turbine drives a main generator and an auxiliary generator mounted in tandem, with the output from the latter units being employed to run the power station auxiliary equipment (Fig. 10). The main alternators are two-pole, star-connected, hydrogen-cooled machines which generate at 20kV, three-phase, 60 c/s, and a 0·85 power factor. They each have a rating of 137·5MW at a hydrogen pressure of 30 lb per square inch gauge. Each main alternator is excited by a separately driven 400kW exciter set, with a third exciter set being available as a standby unit. The hydrogen coolers of the main alternators are fin-tube, two-pass units which are mounted vertically within the alternator housings. The auxiliary alternators are two-pole, star-connected, air-cooled machines which generate at 4·16kV, three-phase, 60 c/s and a 0·8 power factor. They each have a rating of 10MW and are excited by separately driven 45kW exciter sets. Each turbo-generator unit has an overall length of 103ft 5½in, a width of 19ft and a height of 11ft 2in. The turbine weighs 735,000 lb, the main alternator 603,307 lb, and the auxiliary alternator 131,200 lb.

Each generator is protected against phase-to-phase faults by a three-phase, high-speed differential relay connected to current transformers in the neutral leads and in the phase leads of each generator winding. For phase-to-phase faults between the generator and the high-voltage oil circuit breakers, three multi-restraint differential relays are used, one for each phase, connected between current transformers in the generator neutral leads and current transformers in the oil circuit breakers. Out-of-step protection is accomplished by the use of an out-of-step relay which reduces steam flow to a point corresponding to 75 per cent of full load. A loss-of-excitation relay is also provided to disconnect the generator from the 132kV system if the field current fails.

In order to accommodate the side-exhaust turbines, the condensers at Kearny have been arranged in the form of twin units. The tube banks are inverted so that the exhaust steam enters horizontally and flows up to the air cooler at the top, while the condensate falls down to the hot well. De-aeration of the make-up and drains takes place in the steam space ahead of the tube banks. Each twin condenser is supported at about the same elevation as the turbine foundation by four vertical columns connected to support brackets at the top of the shell. The condensers were supplied by the Foster-Wheeler Corporation and each consists of two 35,000 square foot twin units.

Steam Pipework

The entire main steam system, from the superheater outlet header to the first stage nozzle of the turbine, is made of austenitic type 347 stainless steel and the main steam piping was made by forging and boring. The materials of the superheater tubes, starting from the primary end, are carbon steel, carbon-molybdenum steel, chromium-silicon-molybdenum steel, and titanium-stabilised chromium-nickel,

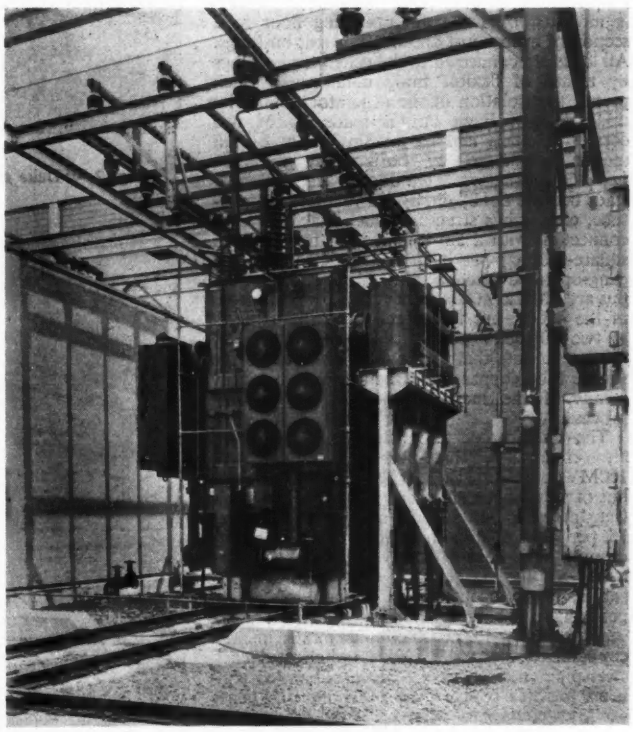


Fig. 11—100MVA Main Transformer

type 321 stainless steel. The hot reheat piping is made of 2¼ per cent chromium, 1 per cent molybdenum steel, rolled from plate and welded. The materials of the reheater tubes of the steam generator, starting from the low temperature end, are carbon-molybdenum steel, chromium-silicon-molybdenum steel, and type 321 stainless steel. The tubes carrying the reheated steam outside the furnace to the principal header are made of chromium-molybdenum steel.

The welded joints in the main steam piping and the turbine high temperature steam piping were made without backing rings, using the "Heliarc" inert-gas shielded tungsten arc process for the first pass, and the shielded metal-arc process for the completion of the weld. A slight pressure of argon gas was applied to the inside of the joint during the first and second passes. Radiographic inspection was made on all joints over 3in pipe size or over ½in wall thickness.

Coal Handling Plant

Since the five boiler units of the original Kearny station have been converted to oil-firing, the existing station facilities were found to be adequate to furnish coal unloading and storage for the new station. Coal is conveyed from existing station bunkers to eight 50-ton silos, there being one for each pulveriser. Each silo holds a four-hour supply at full load operation. Conveyor belts deliver the coal from the bunkers to small hoppers serving Redler conveyors, which are arranged to keep the silos full automatically. The coal for each boiler is weighed on the conveyor belts feeding the hoppers of the Redler conveyors.

Main Switchgear

Each lead from each generator is run as a 5000A, 23kV, metal-enclosed isolated-phase busbar having as component parts surge-protection arresters and capacitors, potential transformers and a main generator gang-operated disconnecting switch. This disconnecting switch is mounted on the main operating floor in a section of busbar just ahead of the exit bushings. All leads are connected to the generator bushings by means of flexible braid connectors, which permit the isolation of the generator for insulation testing. Each bus is made up of two copper channels making an 8in by 8in by ¼in section supported by horizontally mounted opposed insulators. Outdoors, the generator leads become 6in by 6in by ¼in ventilated square-tube, copper bus structure which makes a "T" connection with a 5in by 5in by $\frac{3}{16}$in ventilated square-tube copper bus, rated at 4000A. Two gang-operated disconnecting switches in the 5in bus are rated at 4000A, 23kV. The two branches of the 4000A bus from each generator connect to two 20/138kV power transformers. It is of interest to note that all rigid connections on the square tube copper bus structure were made by means of the inert gas-shielded arc welding process.

The transformers are forced oil and forced air circulation, three-phase units, rated at 100MVA (Fig. 11). If one transformer is out of service, the emergency rating of the other transformer permits it to carry approximately 75 per cent of the maximum main generator output. The 132kV feeders from the transformers to the switch-yard are pipe-enclosed cables, operating at an oil pressure of 200 lb per square inch. Each phase of the feeders consists of one 1,000,000 circular mil. segmental copper cable. In the 132kV switch-yard each steel pipe enters a welded manifold which connects to three copper pipes, carrying one phase each, extending to standard "A"-frame potheads. These potheads connect to four 132kV busbars, which feed into the 132kV transmission system of the company. Low-voltage circuit breakers are not used on the main generators, all switching being done with two 138kV circuit breakers per unit.

The power station was designed by the electric engineering department of the Public Service Electric and Gas Company under the direction of Mr. F. P. Fairchild, Chief Engineer, and was built by United Engineers and Constructors, Incorporated.

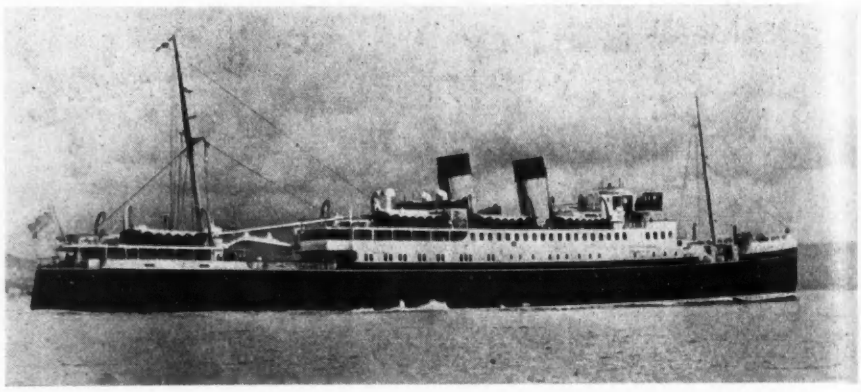


Fig. 1—"Duke of York" as Built in 1935 as a Coal-Burning Steamer for the L.M.S. Belfast Service

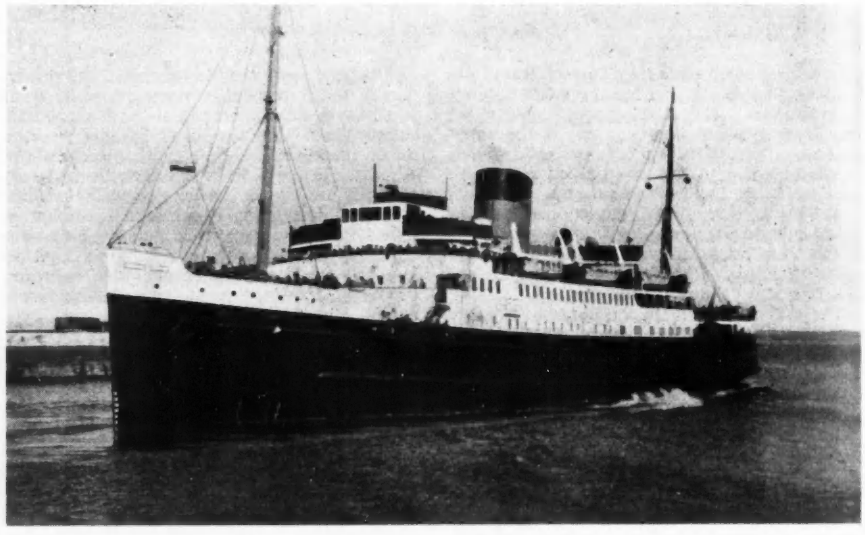


Fig. 2—"Duke of York" as Modified in 1951 for Oil Burning and for the Harwich, Hook of Holland Service

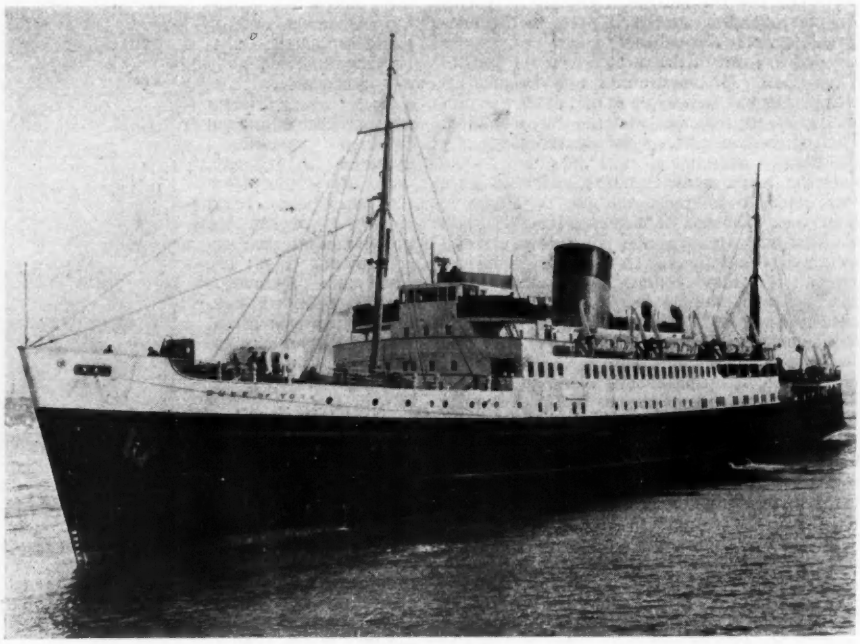


Fig. 3—The Present "Duke of York" (1954)

Reconstruction of Steam Ship "Duke of York"

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

The turbine steamer "Duke of York," which has just re-entered service, is here described. She was built in 1935 for the L.M.S. Belfast run, and after the war was given a radical reconstruction to fit her for the Hook of Holland–Harwich service. In May, 1953, she was in collision with a cargo ship about 11 miles from Harwich, some 90ft of the bow being sheared off. A new bow has now been fitted and other changes made.

THE cross-channel turbine steamer "Duke of York" has had a very varied career, and in a way has been a lone ship from the very start. In 1928 the London, Midland and Scottish Railway put three fine turbine steamers, "Duke of Lancaster," "Duke of Argyll" and "Duke of Rothesay," on its Belfast service. They soon became so popular that it was decided to add a new steamer to the fleet, with a result that "Duke of York" came on the scene in 1935. Instead of being a sister ship to the trio she was different in that she was 10ft shorter and had a smaller beam and depth, but her tonnage was 3743 gross, as compared with 3606 tons of the older ships, and from her general appearance she gave the impression of being sturdier, her good looks being shown in the illustration, Fig. 1. When built she was a coal burner with mechanical stoking. During the war, as H.M.S. "Duke of Wellington," she rendered useful service.

At this time, as might be expected, the east coast steamers had a high casualty list, and of the three steamers built in 1929/30, for the service from Parkeston Quay, Harwich, to the Hook of Holland, "Amsterdam" was sunk off Normandy in 1944; later "Prague" was so badly damaged by fire when being reconditioned that eventually she had to be broken up, and the third ship, "Vienna," was engaged on trooping, a service which seemed likely to continue almost indefinitely. Accordingly, new tonnage was essential if daily sailings were to be resumed, and "Arnhem," the largest vessel ever designed for this route, began her career in 1947, to be followed in 1950 by "Amsterdam," a vessel already described in these pages.* The decision was made by British Railways to transfer "Duke of York" from Heysham to Harwich, where she assumed her new duties in 1948. She no longer needed space for the carriage of cattle, cargo, &c., and it was considered necessary to make a number of structural changes to render her more suitable for the sailings to Holland. Accordingly, in 1950, she was sent to Harland and Wolff's yard at Belfast for conversion to oil burning, which in its turn afforded the opportunity of making some radical changes which considerably altered her general appearance (Fig. 2). By the removal of one of her funnels it was possible considerably to increase the size of both dining saloon and smoke room, while some of the cargo space forward was converted to passenger cabins, as also were the spaces of what were originally gravity bunkers. In the part of the ship devoted to second-class passengers large public rooms were converted into cabins. The result of all these alterations was that although the number of passengers was only increased by one, cabin accommodation could be provided for 359 first-class passengers instead of 243, and the second-class berths were increased from eighty-six to 160, leading to a reduction of unberthed passengers from 346 to 157. While the registered dimensions remained the same, viz.: length 339·2ft, breadth 52·2ft, depth 17·9ft, the tonnage was increased from 3743 to 4190·13 gross, and from 1547 to 1904·28 net.

*THE ENGINEER, June 23, 1950

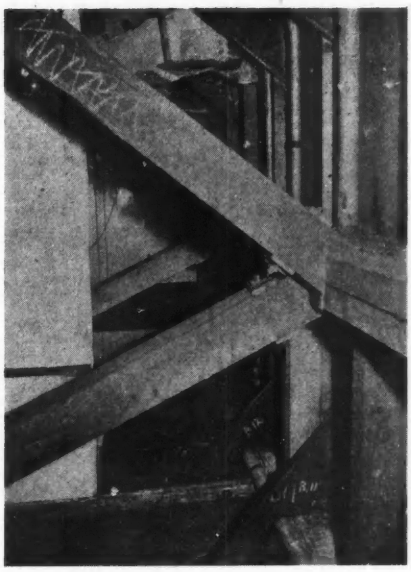


Fig. 6—Stiffening of Lower Deck Bulkhead

It was anticipated that as reconstructed the ship was to have many useful years to her credit, but this was not to be, for at 3 a.m. on May 6, 1953, when returning from the Hook of Holland to Parkeston Quay, having reached the vicinity of the Galloper lightship, about 11 miles from Harwich, a collision occurred with the United States vessel "Haiti Victory," whose bows penetrated into the port side of "Duke of York" for two-thirds of her width, just forward

Fig. 4—Ship as First Dry-docked at Hebburn, Showing Collision Damage. The Fore-Part was Sheared Away and Sank

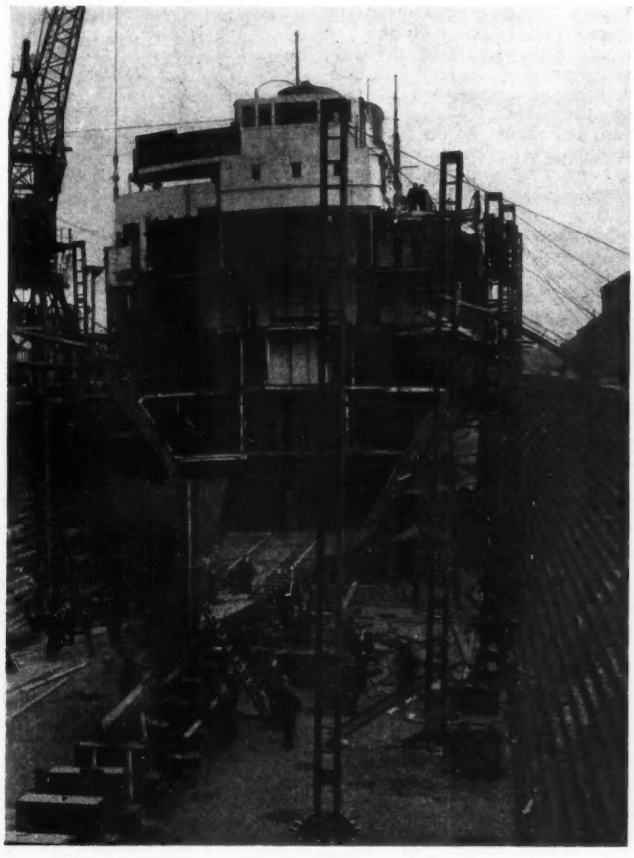


Fig. 5—Reconstruction of Bow Begun in Dry Dock September, 1953

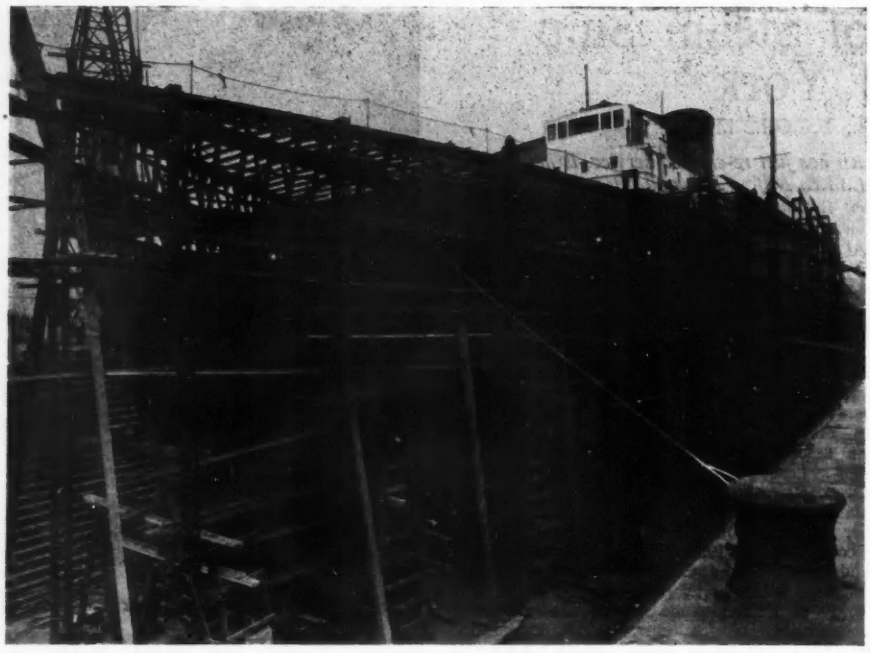


Fig. 7—Reconstruction of "Duke of York" After Suffering Collision Damage, November, 1953

of the navigation bridge, so that some 90ft of the bow portion were nearly sheared off. After being suspended in a practically water-logged condition for the space of about an hour, this portion broke adrift and sank. Had the accident occurred but a few seconds later the loss of life would probably have been considerable; as it was eight lives were lost. The crippled vessel was towed safely into Harwich and there moored, the time being 11 p.m. Next morning she was brought alongside Parkeston Quay, where temporary repairs were at once put in hand. It was found that in coming alongside "Haiti Victory" had damaged the davits and caused considerable buckling on the port side. The repairs mainly consisted in the shoring-up and stiffening of the forward bulkhead to resist the pressure of the sea and so enable her to be safely towed away to be fully repaired at Palmer's yard at Hebburn on the Tyne. The sort of stiffener used is shown in the illustration, Fig. 6.

For her repair alternative proposals had been made, one being to make a new fore part and to join it to the undamaged part, while the other was to dry dock her and build up a new bow in position; the latter course was adopted. On the evening of May 27th the vessel was taken in tow by the tug "Englishman" and the voyage to the Tyne was commenced, but her adventures were not yet over, for when off the Humber a northerly gale was encountered and from observation it appeared that the forward bulkheads were showing signs of yielding due to the excessive strain caused by the heavy seas that were beating against the ship. It appeared expedient for the vessel to put into Immingham on May 29th for further stiffening to be undertaken. This done, the tow was resumed at 2.15 p.m. on June 7th, and Palmer's yard was reached at 4 p.m. on the following day without further incident.

The ship was docked on June 22nd (Fig. 4) for a complete survey to be made, after which she was undocked, all the damaged structure being cleared away, and the construction of new frames, floors, beams and other necessary parts was put in hand. For the actual rebuilding when the new parts were in a sufficiently advanced state, the ship was transferred to Palmer's Jarrow dry dock on August 28th (Fig. 5). The progress that was then made can be clearly seen from Fig. 7 above. Three months later, on November 24th, to be exact, a complete steamer was refloated (Fig. 3). Work on the ship was completed on January 15, 1954, and in the afternoon she left the Tyne for Harwich, which was reached in the morning of the 17th, and on the 25th her normal sailings to the Hook of Holland were resumed.

Opportunity had been taken to make several important structural alterations, among which may be mentioned that from a straight bar stem to a soft nose raked stem, and the removal of the bow rudder, which, while it had been invaluable in sailing astern up to Belfast, was no longer needed, and this in turn enabled the navigation bridge abaft the funnel to be dispensed with. Another important change was the removal of the forward well deck, a flush deck being carried forward at the level of the promenade deck, which made possible the provision of more passenger accommodation below. The crew, which had been previously housed in the forecastle, were now given comfortable quarters amidships on the port side. It had been found necessary to cut back into the remaining structure of the ship a distance of 20ft, making the total length removed and replaced about 110ft. An additional water-tight bulkhead was fitted in the new structure, thereby giving a two-compartment subdivision. The alteration in passenger accommodation is almost negligible, there being one more first-class berth, but two less unberthed passengers, making the passenger certificate stand at 675 against the former 676. The greatest dimensional alteration is the increase in length of 9ft, the leading dimensions now being: length 346·7ft, breadth 52·2ft, depth 17·9ft, tonnage 4325·28 gross, 1980·19 net.

The writer, in going over the reconstructed vessel, was impressed by the great improvement that had been effected, so that now "Duke of York" has become a modern high-class steamer well able to take her place as a suitable consort of the newer "Arnhem" and "Amsterdam", while her smooth running and steadiness in a seaway were very noticeable. Incidentally, it might be mentioned that the "Arnhem" which began her career experimentally as a one-class steamer is now being converted to two-class.

Thanks are accorded to the officials of British Railways, both at Parkeston Quay and in London, for the help and facilities so readily afforded in connection with the preparation of this article.

Heavy Duty Plate Bending and Straightening Machine

A PLATE bending and straightening machine designed to fulfil the requirements of those fabricating shops in which the output does not justify the installation of separate machines for levelling and for curving plates, is illustrated on this page. It has been made by Joshua Bigwood and Son, Ltd., Wolverhampton, and is thought to be the largest of its kind made in this country.

The machine has three rolls arranged in pyramid, which are used in the usual way for rolling plates to cylindrical or conical forms; in addition there is a fourth roll which can be quickly set into position thereby converting the machine into a four-roll leveller.

All movements are motorised and may be controlled remotely from a single station. The general specifications are given in the table.

The rolls are machined from high carbon steel forgings, the housings being heavy steel castings which carry the two bottom rolls in large phosphor bronze sleeve bearings. Chocks working in slides machined in the housings between the lower roll-bearings and secured by thrust pins to heavy adjusting screws, carry the top roll. The worm and wormwheel nut and heavy duty roller thrust bearing, forming the top roll adjusting gear, are enclosed in the housing castings and are driven through reduction gearing by an electric motor.

A slipring motor provides the main drive,

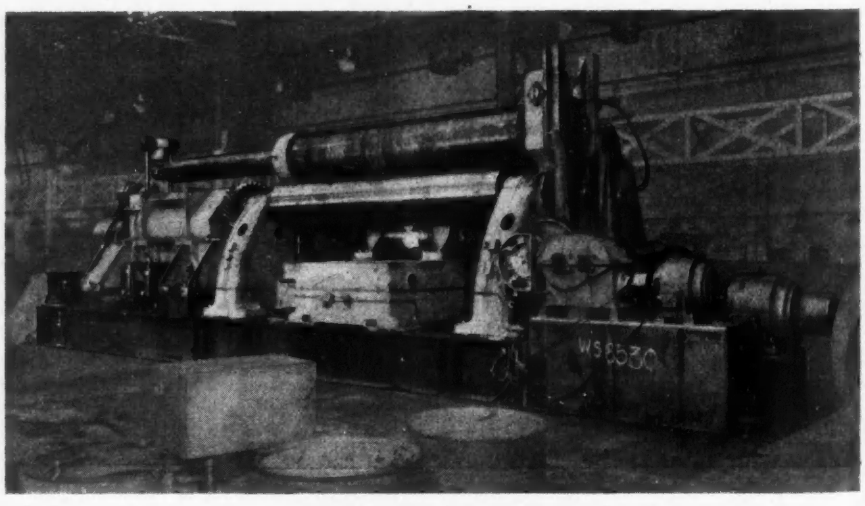


Plate Bending and Straightening Machine

which is connected through a Bibby coupling to the main gearbox. This gearbox is of heavy steel fabrication containing double helical steel gears. All bearing shafts and gears are so located that the top part of the box can be removed without disturbing any of the running parts, thus allowing rapid and easy access for inspection and maintenance. For lubrication purposes the gearbox is sectionalised, the high-speed section being lubricated by oil bath and the low-speed section by pump feed.

The top roll is extended to terminate in a ball end under a swivelling yoke, which forms part of the jacking screw mechanism used to balance the weight of the top roll and so relieve the pressure on the outer bearing when its housing is swung clear of the machine to make possible the removal of closed circular forms from the rolls. This bearing housing, the weight of which is counter balanced, is swung by levers and quadrant and pinion gearing.

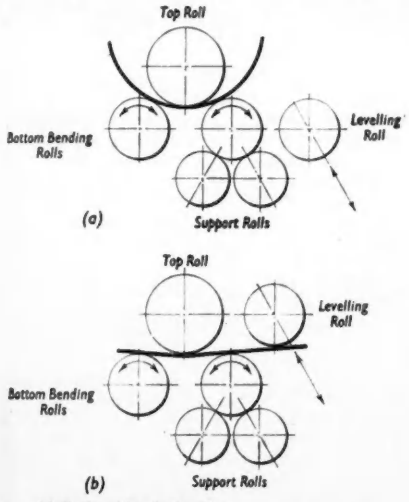
General Specification

Maximum plate width	12ft
Maximum plate thickness	1¼in in 28/32-ton tensile mild steel 1¼in in 45-ton tensile steel
Roll length	12ft 4in
Top roll, diameter	26in
Bottom rolls, diameter	22½in
Straightening roll, diameter	17in
Support rolls, diameter	18in
Rolling speed, forward and reverse	13ft per minute
Minimum circle rolled :	
On 1¼in plate	39in
On ¾in plate	32in
Main motor	110 h.p., 720 r.p.m.
Top roll adjusting motor	50 h.p., 720 r.p.m.
Jacking screw motor	7½ h.p.
Swinging end bearing motor	10 h.p.
Straightening roll adjusting motor	15 h.p.
Overall dimensions	41ft 6in by 12ft 9in by 12ft 6in
Weight of top roll	13 tons 8 cwt
Nett weight of complete machine	116 tons 2 cwt

The motive power is provided by an electric motor, driving through a slipping clutch. It should be noted that only the bearing housing is removed, the bearing itself being left undisturbed on the roll journal ; this precludes the possibility of dirt getting on to the bearing surfaces, or of their suffering mechanical damage. The motor is push-button operated and is fitted with plug braking.

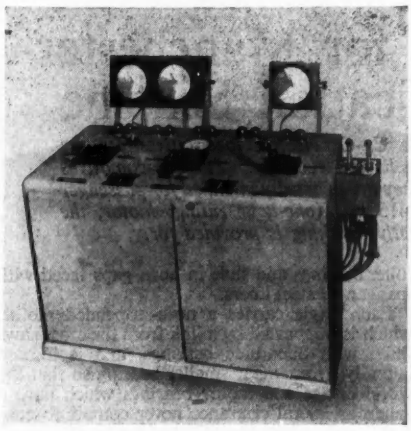
An air-operated clutch is included in the drive for top roll vertical adjustment and when this is disengaged the inner end of the roll can be moved independently of the outer end ; thus, the top roll can be tilted in order to bend plates into conical forms. The positions occupied by the rolls during bending are indicated in the diagram reproduced herewith. The lower drawing (*b*) shows the positions occupied by the rolls when the machine is being used as a four-roll leveller. The levelling roll is carried in chocks which are guided in inclined slides in the housings.

When the machine is being used for bending, this roll is depressed and occupies the position shown in the upper drawing (*a*) and for levelling it is raised to the position shown in (*b*).



(*a*) Roll position for bending.
(*b*) Roll position when used as a four-roll leveller.

Positions Occupied by the Rolls During Bending and Straightening



Control Desk Housing Motor Controllers, Air Control Valves and Indicating Meters

Comprehensive electrical interlocks must, of necessity, be provided, otherwise serious damage may result through inadvertent or incorrect operation when counter balancing the 13½ tons of the top roll.

The interlock protective devices for the top and bottom positions of the top roll provide adjustment by micro limit switches incorporated in the magslip indicator assembly to prevent the top roll being lowered to touch the bottom rolls, or to be raised too high out of its adjusting screw nuts. A further limit switch is provided to control the maximum positions of the top roll when inclining it for cone rolling.

In order to protect the jacking screw yoke, the top roll can only be raised or lowered when the jacking screw is in its uppermost position, which is indicated by a green signal lamp on the control desk. The swinging end bearing, in turn, cannot be retracted unless the correct pressure is applied by the jacking screw on the ball end of the top roll, that pressure being sufficient not merely to take the weight of the roll but to counter balance its inherent deflection due to its weight. A simple, patented device controls this degree of additional deflection required on the extension of the top roll to counter balance it, so that the swinging end bearing is free to be withdrawn by the powered swinging arms.

When the swinging bearing is out of position, i.e. the roll is cantilevered, the jacking screw gear is interlocked electrically to prevent it being raised again until the swinging bearing is back in the position of supporting the outer end of the top roll. The positions of these various units are indicated by red and green lamps on the central control desk, so that the operator can readily see whether the electrical interlocks are functioning satisfactorily.

Electrical magslips supplied by the Metronic Instrument Company comprise transmitting units on the machine, cable connected to receivers forming the dial, and pointer position indicators for each end of the top roll. This electrical control of the indicator system permits the control cubicle to be sited at a convenient position at any distance from the machine, preferably one which gives full view of either side of the top roll and the various important control units.

Magslip indicators show at the control desk the positions occupied by the bending roll and the levelling roll.

In this machine, the bottom bending roll on the side adjacent to the levelling roll is reinforced to take the heavier load by a pair of support rollers at the centre of its span. These rollers run in phosphor bronze bearings which are carried in a cast iron cradle mounted on the main bed. The main bed is a fabricated steel construction and runs the full length of the machine. On it are mounted on machined facings the driving motor, gearbox, housings, &c. This ensures accurate alignment of all component parts and makes it possible to maintain a single foundation level throughout.

The four motor controllers, air control valves, indicating dials, &c., are mounted on a control desk, as illustrated, so that a single operator can exercise complete control from one point.

Two centralised Farvalube lubricating systems are incorporated to ensure the effective lubrication of all bearing points.

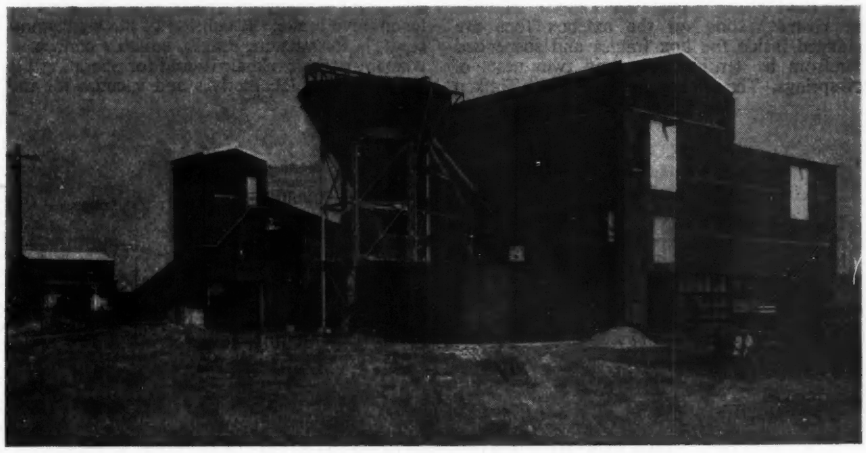
Similar dual purpose machines with an additional straightening roll for five-roll levelling, are also manufactured by the company. All the electric motors for the machine were supplied by Brook Motors, Ltd., and the control gear by Contactor Switchgear, Ltd.

Coal Washery

AN illustration on this page shows a new coal preparation plant, the first of its kind, which has recently been installed by Simon-Carves, Ltd., at Gidlow, Wigan. An interesting feature of this plant, jointly designed by Simon-Carves, Ltd., and the National Coal Board, is that it can, if necessary, be dismantled and re-erected on another site. Its working life does not, therefore, depend on continuing coal supplies in the area which it serves at present.

To facilitate transfer from one site to another, the use of reinforced concrete in the construction of the plant has been kept to a minimum. Steel construction is used throughout for buildings and structures, which are clad with " Cellactite " sheets on the sides and are roofed with asbestos. The slurry tank and flocculation tank are built of riveted and bolted steel plates which can be readily dismantled.

The capital cost of this plant is stated to have been substantially less than that of a plant of equal capacity and orthodox construction. It is being used for the treatment of 200 tons per hour of run-of-mine coal from a number of Lancashire pits. The installation incorporates a Baum wash box, classifying screens and flocculation and filter plant for fines treatment. From it cleaned coal is loaded on rail or road vehicles in grades of 6in–4in, 4in–2in, 2in–1in, and 1in–0in, whilst the shale is conveyed to a bunker for loading road lorries or dumpers.



Coal Preparation Plant at Gidlow

C_0-C_0 Locomotive for Manchester-Sheffield Electrification Scheme

The first of seven double-bogie, six-axle C_0–C_0 electric locomotives for the Manchester-Sheffield electrification was delivered recently. These locomotives are suitable for mixed traffic working, but they are primarily intended for passenger service. Each axle is gear driven by a 415 h.p. (one-hour rating) motor, the maximum speed is 90 m.p.h., and regenerative braking is provided for.

WE illustrate the first of seven double-bogie C_0–C_0 locomotives which was delivered recently for service on the Manchester–Sheffield electrification of British Railways, London Midland Region. Although these locomotives are classed as mixed-traffic units they are intended mainly for passenger working. They are therefore provided with an electric boiler for train heating and they are designed for a maximum speed of 90 m.p.h.

The main dimensions are : length over buffers, 59ft ; wheel base, 46ft 2in ; distance between bogie centres, 30ft 6in ; overall width, 8ft 10in. The weight in working order is 102 tons. Each axle is driven through 17 : 64 reduction gearing by a 415 h.p. motor.

In general, the cab layout is similar to that of the B_0–B_0 locomotives which are now in service on the Wath branch of the electrification. The cab at each end is connected by a corridor along one side of the locomotive and from the corridor access can be gained to the high-tension and resistance compartments and to the boiler and machinery compartments.

There is a door in the high-tension chamber giving access to the resistances ; it is mechanically and electrically interlocked by the reverser key on the master controller so that it can only be opened when the power on the locomotive (1500V d.c.) is off and the pantographs lowered.

Both cabs contain the straight air and vacuum brake valves on the driver's left hand and the master controller and auxiliary switches on his right hand, while the instrument and gauge panel is mounted in front. The driver's seat is adjustable for height and the deadman's pedal and sanding switch are at his feet. A push button is provided on the right-hand side of the driver's desk so that operation of the deadman's device can be prevented should the driver wish to cross to the other side of the cab, a suitable delay being provided to permit this.

The buffing and draw gear is mounted on the body understructure, which consists of rolled steel sections suitably cross braced and stiffened over the large diameter bogie centres. The bogie frames are of box section fabricated from $\frac{7}{16}$in plates, with their centres located on the centre line of the axleboxes. They are braced together by two cast steel cross stays in which the double bolster can slide transversely and through which the tractive force is transmitted via the bolster to the bogie centre on the body structure.

The weight of the body is carried by four spherical bearers sliding on each bolster which in turn rests on laminated springs supported by swing links from the bogie cross stays. Equalising beams resting on the axlebox tops are arranged inside the box frames and suspended therefrom by tension bolts and twin nests of coil springs. The axleboxes are fitted with Timken roller bearings and slide in horn gaps faced with manganese steel liners.

Each bogie carries a nose-suspended motor, which is supported by a link from the cross stays fitted with Silentbloc bearings, and is located laterally by a similar smaller bearing so that the wheel bosses and motor bearings which have a generous lateral clearance never come into contact. All movement of the motor is accommodated by the Silentblocs.

Each axle is driven through single reduction, resilient gearing having a ratio of 17 : 64. The one-hour rating of the traction motors is 415 h.p. and three different groupings of the traction motor connections are available : (*a*) all six motors in series, (*b*) two parallel groups of three motors in series, and (*c*) three parallel groups of two motors in series.

The master controller and contactor equipment are arranged to cater for these motor groupings. The control gear is electro-pneumatic and is operated through contactors from the master controller in the cab—the accelerating lever controlling the notching up through and transition between all three motor combinations. There are three banks of starting resistances.

Braking is by the Westinghouse vacuum-controlled straight air system with independent locomotive brake. It consists of air brakes and controls for vacuum brakes, suitably connected whereby compressed air is used for operating the brakes on the locomotives and vacuum for the train. Both systems have automatic action for deadman's emergency or breakaway. The locomotive brake can be operated separately or in synchronism with the train brake.

Compressed air for braking, for the electro-pneumatic valves, sanding gear and "pneuphonic" horns is supplied by a motor-driven compressor and the vacuum is provided by a Westinghouse motor-driven exhauster. There are four brake cylinders on each bogie and the rigging is operated through Westinghouse slack adjusters.

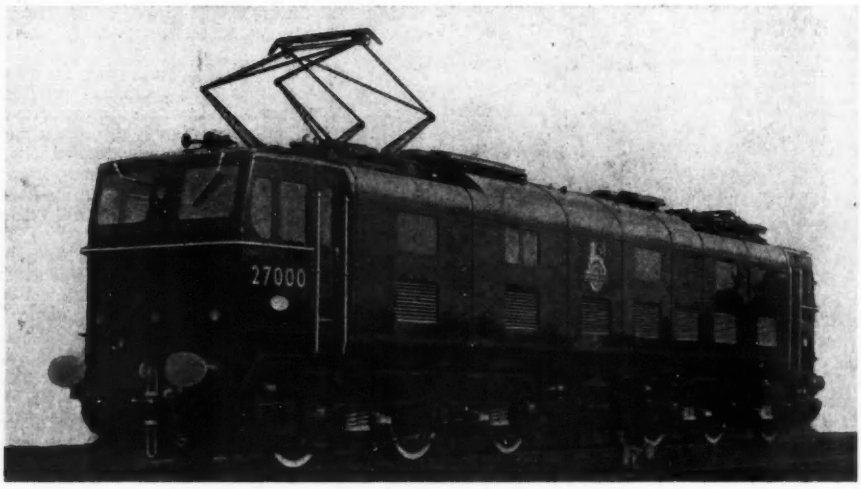
Regenerative Braking

Besides the air brake system the locomotive is fitted with regenerative braking and with means for an immediate equivalent air brake application in the event of failure of the regenerative braking.

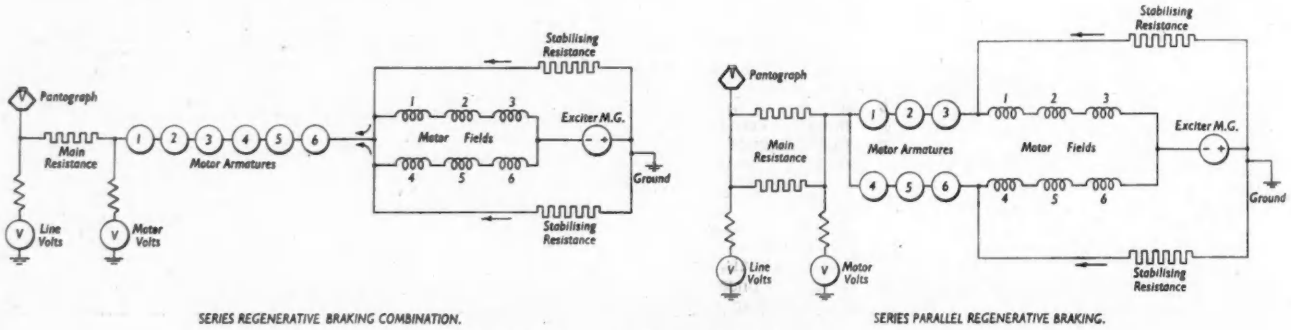
In the accompanying diagrams we illustrate the motor groupings used during regeneration. To obtain the regenerated current the main motor fields are separately excited by the exciter motor generator set accommodated in the No. 2 machinery compartment, the generator armature being connected in series with the motor fields.

To provide the necessary stability to compensate for changes in line voltage and, therefore, automatically to maintain the regenerated current and motor torque at a constant value two stabilising resistances are provided, one associated with each set of three motor fields. As may be seen from the diagrams, these stabilising resistances carry both the field exciting current and the regenerated current.

The operation of the circuit may be explained as follows. First, assuming that the line voltage falls considerably during regeneration, then, as the field current of the motor is momentarily unchanged, the regenerated current will rise. When the regenerated current rises, the voltage drop across the stabilising resistance increases. As the stabilising resistance is also in series with the main motor fields, this increase of voltage drop will decrease the current flowing through the main motor fields, and thus reduce the voltage generated by the main motor armatures,



C_0-C_0 Locomotive for Manchester-Sheffield Electrification Scheme



Motor Connections for Regenerative Braking

thereby limiting the rise of regenerated current.

Secondly, assuming that the line voltage rises considerably (the field current of the main motors being momentarily unchanged) the regenerated current will fall, and may even be changed to a motoring current.

When the regenerated current falls, the voltage drop across the stabilising resistance decreases. As the stabilising resistance is also in series with the motor fields, the voltage drop will increase the current flowing through the main motor fields, and thus increase the voltage generated by the main traction motors, thereby limiting the fall of the regenerated current. If motoring is being done on the regenerative connection, the effect of the stabilising resistance will be similar, increasing the strength of the main motor fields and keeping down the motoring current. The field current is in the same direction for motoring as for regeneration.

Regenerative braking can be used in both the series and series-parallel motor combinations. In general, the series combination may be used for speeds between 16 and 40 m.p.h. and the series-parallel combination for speeds between 33 and 60 m.p.h.

On each motor combination the regenerative handle on the master controller is used to control the speed of the locomotive by regulating the value of the regenerated current. For this purpose the field of the exciter generator is excited from the supply generator and is regulated by an exciter field resistance, the value of which is adjusted by suitable cam-operated fingers on the regenerative shaft of the master controller.

On a falling gradient of constant value, weakening the field current will result in an increased speed and a decrease in the regenerated current, while strengthening the field current, will result in a decreased speed and an increase in the regenerated current.

To increase the speed the regenerative handle is moved from a higher to a lower notch, thus weakening the exciting current of the exciter generator, which, in turn, weakens the field current of the main motors. To decrease the speed the regenerative handle is moved from a lower to a higher notch thus strengthening the exciting current of the exciter generator, which, in turn, strengthens the field current of the main motors.

Two ammeters are mounted in each driver's cab. One is connected in series with the motor armatures and is a centre reading instrument indicating both motoring and regenerating currents. The other is connected in series with the motor fields and indicates the field current. An overvoltage relay is included in the control equipment to open the line switches if an excesive voltage is generated by the main motors due to faulty manipulation of the master controller handles, or due to causes external to the locomotive such as the absence of load to absorb the regenerated current.

Two voltmeters are provided in each driver's cab. One voltmeter indicates the line potential and the other the voltage across the motors in either the series or series-parallel combinations. The motor voltmeter is used in regenerative braking to enable the driver to adjust the voltage generated by the traction motors to approximately the same voltage as the line before making the entry into regenerative braking.

The motor generator set previously mentioned for exciting the motors during regeneration also drives the blower for cooling the traction motors at No. 2 end bogie. A similar motor generator set is provided at the other end for supplying current of 50V for charging the battery, for the control gear, for lighting, heating and driving the blower for the motors on the bogie at No. 1 end.

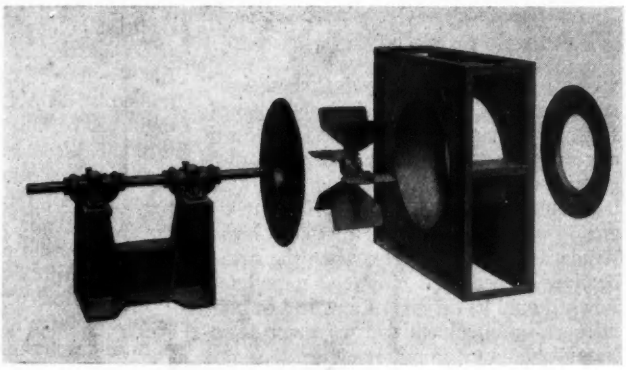
The mechanical parts of the locomotives were built at the Gorton Works of the British Transport Commission and the electrical equipment was supplied by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester.

Adaptable Paddle Blade Fan

A DESIGN of paddle blade centrifugal fan now being made by Matthews and Yates, Ltd., Cyclone Works, Swinton, Manchester, enables the discharge direction or direction of rotation to be easily changed or set on site by simple rearrangement of the component parts.

The simple construction of the fan and the ease with which it can be adapted to suit conditions can be seen from the photograph we reproduce below. Its symmetrical casing has an angle section frame and the angles on all sides are drilled with identical foundation holes so that whichever side is set on the floor becomes the base of the installation. The cover plates on each side can be changed over to provide a right or left-hand drive as required. The fan shaft is mounted in substantial bearings on a heavy pedestal and is designed for either a direct motor or vee belt drive. The paddle fan can be set on its shaft to operate in either direction of rotation.

Alterations to the fan arrangement are quickly and easily made. For example, if it is assembled with its discharge vertically upwards and a downwards discharge is required, the drive side cover plate, bearing housing, shaft and impeller are removed as a complete unit. The fan casing is then rolled over until the discharge points downwards and then the cover plate assembly is replaced.



Component Parts of Paddle Blade Fan

To change the rotation of the fan it is merely a matter of changing over the cover plates. Both cover plates are removed, the impeller is taken off the shaft and reversed to give the new direction of rotation and then the cover plates are changed over to the opposite sides of the fan and bolted up again.

Wire Thread Inserts

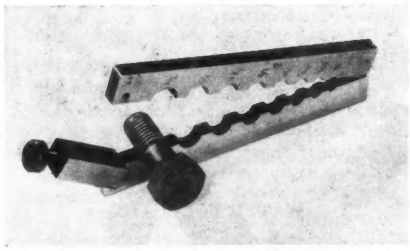
WIRE thread inserts are now being manufactured by the Cross Manufacturing Company (1938), Ltd., Bath, Somerset, which provide a hard, strong thread in soft metals, plastics and even wood. The insert is a wire coil having a thread form both on the bore and on the outside diameter. It screws into a tapped hole larger than the normal size, has a slight springy interference fit with its mating part and provides a hard, smooth internal thread. With new equipment, particularly of light alloy, it has many applications for seating set screws involving frequent adjustment or removal. Its light weight makes it particularly useful in aircraft where it is now being extensively used. Feed screw threads and jig adjustment bolts are other applications in ferrous metals. Salvage is another important field of application, particularly in light alloys, where, due to their poor shear strength, thread stripping is relatively common. Such a hole can be tapped out with an insert tap and a wire insert fitted, the finished tapped hole being the same size as it was originally.

The fitting of the insert is a simple operation, the hole being drilled to the dimensions shown on the company's data sheets and the appropriate insert tap used for threading. A special tool is used for screwing the insert in, which must finish below the surface of the metal.

Inserts are of special advantage where an interference fit is required, as it avoids the tendency in light alloys for the metal surface to disrupt and jam the stud. The insert is forced outwards into the aluminium without turning in it, and if a suitable lubricant is employed very tight fits are possible. So far, the company states, it has found no trace of electrolytic corrosion having occurred.

Bolt Reconditioning Tool

A SIMPLE design of bolt reconditioning tool is now being made in an improved form by Laurence Edwards and Co., Commercial Buildings, Oxford Street, Kidderminster. This tool,



Bolt Reconditioning Tool

as can be seen in the illustration above, consists of a pair of plates hinged at one end and fitted with a clamp at the opposite end. Machined on the abutting faces of each plate are threaded holes in a range of sizes from ¼in to ¾in Whitworth or B.S.F. or A.N.F. threads.

To use the tool the two plates are opened and the damaged, dirty or rusty bolt is placed in the appropriate screwed half hole, as shown in the illustration. The plates are then closed on the bolt and the clamp swung over to lock the assembly. The threads of the bolt are then cleaned or reconditioned as it is screwed out of the tool. A narrow gap between the two plate sections makes it possible to handle sub-standard bolts by tightening the clamp to the actual diameter. Dirt and rust removed as a bolt is unscrewed are cleared in the gap.

Book of Reference

Ship and Boat Builder Annual Review, 1954. London: John Trudell (Publishers), Ltd., Temple Chambers, Temple Avenue, E.C.4. Price 30s.—The 1954 edition of the *Ship and Boat Builder Annual Review* is arranged in the same manner as the previous year's edition, but with each section revised, brought up to date and expanded as required to include additional information. There is a directory of British boatbuilding and repair yards for craft up to 1000 tons gross arranged in alphabetical order, and then repeated with the firms grouped geographically. This is followed by a geographical index of overseas boatbuilders. As in former years, the specifications of main, auxiliary and outboard engines are listed under the names of individual manufacturers and then in the materials, fittings and equipment section information is recorded with regard to paint specifications, marine fittings, materials, timber applications, yard equipment, and there is an index to manufacturers and suppliers. Other directories in the volume refer to consultants, various associations, British owners of small craft, dock and harbour authorities, yacht clubs and commercial diplomatic officers and trade commissioners. The review also contains several short articles related to the industry. In these the changing face of the Navy is discussed, a survey of overseas markets for small craft is given, new marine equipment is reviewed together with short descriptions of craft completed in 1953, accompanied by a tabular statement of launches. Other subjects discussed are whether to fit a petrol or diesel engine, the painting of yard buildings, navigational aids and welding in the shipyard.

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WATER POLLUTION

As spring develops, and as April sweeps into May, our Editor's thoughts invariably turn towards angling and the casting of a fly at a trout. Nor is it a subject wholly unsuited to the thoughts of the editor of so sober a technical journal as this at this time of year. For trout inhabit only unpolluted streams; and by one of those peculiar but delightful coincidences with which life abounds there have arrived on the Editor's table during the last few days three separate documents that refer to the pollution of water. One is the annual report of the Water Pollution Research Board for 1953, the second is the 37th annual report of the Federation of British Industries, and the last the Quarterly Review of the Anglers Co-operative Association. Each in its own way treats of the same subject, and the three together show more clearly than could any one alone what is the present position in this country, what activity there is in preventing water pollution and what are the hopes for the future. The importance of the subject scarcely needs stressing. For it is not anglers alone that benefit from unpolluted streams. Nor is amenity the only other factor involved, desirable though it is upon that ground that unsightly blackened waters, in which no vegetation grows, should be banished from the land. As the demands of people in this country grow for water for household and industrial use, and as standards of housing improve, so does it become more essential to preserve and, indeed, increase the sources of supply of pure water. So, too, does it become essential to ensure that the increasing flow of sewage is adequately treated and that industrial and other effluents are not discharged without treatment into streams and rivers in which people bathe and from which cattle drink.

It has never been easy satisfactorily to define what constitutes a harmless effluent. No doubt that is one of the reasons why in recent discussions with the River Board's Association the Federation of British Industries suggested that "Royal Commission" standards should not be slavishly adopted. Perhaps it had in mind how senseless it appears to be to insist on a high standard of effluent when the water into which it flows is already highly polluted. We hope it had also in mind the possibility that even higher standards may be desirable when the stream or river concerned is clear and unpolluted. For it should be the aim of any firm or body discharging an effluent that the water downstream should be no more polluted than that above the effluent discharge. It cannot, unfortunately, be the object as distinct from a mere aim. For not all industrial effluents can yet be effectively treated, the efficacy of some treatments is open to doubt, and the cost of treatment cannot always be regarded as negligible in relation to the object to be served. The angler comes into this discussion because, probably, there is no better a test of the nature of an effluent than its effects upon fish life. Oxygen content or oxygen demand, important though they are, are still not, by themselves, satisfactory measurements of toxic quality. As the Board's report points out, an effluent innocuous by day may prove fatal to fish by night in a weedy river, because in such a river the oxygen content normally falls during the dark hours and because, under those circumstances small amounts of such substances as ammonia may then become toxic. But the Board's researches are not wholly concerned with the treatment of sewage and industrial wastes. Unhappily there are in this land waters so very heavily polluted already that no test with fishes is needed to determine their state. One of those places is the mouth of the Thames. Much of the work of the Water Pollution Research Laboratory has been concentrated upon surveying its state with the eventual object of facilitating decisions upon the policy for the future of the estuary, notably policy in relation to the discharge of sewage and trade wastes and the extent to which the water temperature can be permitted to be raised through the use of cooling water in power station condensers. Such information as has been gathered is not reassuring. Ten miles below London Bridge at all seasons of the year and for a length of about 10 miles there is no dissolved oxygen at all in the water at least during part of a tide; and even at London Bridge and above something approaching a similar state can be reached when the flow of the Thames is low. Such a condition of the river within the bounds of the City is no credit to London.

But, important though the work of the Research Board is, promising as the operations of the River Boards seem, perhaps the body whose activities industry and local authorities will most closely watch is the Anglers Co-operative Association. For its peculiar importance lies in the fact that it has demonstrated during the last few years that legal action can effectively be taken to prevent pollution. No doubt its operations are not always welcome to industrial firms and local authorities, with whose problems it may sometimes seem out of sympathy. But unquestionably the general effect of its work is beneficial. For it is our belief that the bulk of industrial firms have as much desire as other people to see the streams and rivers of this country flowing unpolluted. The National Coal Board, for example, is quoted by the A.C.A. as having "inherited a multitude of sins" of which it is "trying to repent." We know of at least one engineering firm through whose works there flows a salmon river, unpolluted. But when little action was, nor seemed capable of being, taken to prevent pollution, when other firms without retribution, even if clandestinely, poured noxious effluents into the waters what sense was there in firms with a higher sense of social responsibility refraining? What can be done where persistent offenders are brought to book has long been demonstrated by the Thames Conservancy Board, which keeps the Thames pure enough to support abundant fish life from its sources to the tideway. Newer River Boards, particularly those operating in more highly industrialised valleys, will, no doubt, have greater problems to solve. But since the ability of a water to support a stock of fish seems as good a test of pollution as any other, it can be seen that the activities of the A.C.A. must parallel, rather than run counter to, that of River Boards.

SHIPBUILDING AND SHIPPING OUTLOOK

The position of the shipbuilding and shipping industries was the central theme running through the speech made recently by Viscount Runciman of Doxford, the president of the Institution of Naval Architects, on the occasion of the annual dinner of that Institution. During the course of his remarks he commented upon the full order books of the shipyards, a position which, he thought, gave no cause for complacency when due regard was given to the volume of new orders. He gave a thought to present-day costs and dwelt upon the relationship between the present total of world tonnage, the volume of world trade and the current level of freight rates, and considered the resultant general effect upon the placing of orders for new ships. Another aspect of the present-day situation which he stressed was the steady decline in the percentage of world tonnage

built in this country. The upsurge of foreign competition can obviously, as he said, only be countered by building cheaper ships. That was an objective difficult enough to attain, but one which was becoming essential. He thought it might be attained by concentrating on simplification rather than complication.

The reason for the present worldwide fall in the placing of contracts for new ships is not the result of one particular factor, but the cumulative effect of many. However, a major influence is that last year the volume of world tonnage reached a total which at least satisfies the present demands of world trade. The ordering of new ships tends, therefore, to be now restricted mainly to the replacement of older and inefficient units that have reached the ends of their profitable lives. Yet though world shipbuilding seems to have passed its post-war peak, many Continental shipyards are still managing to increase their outputs. That is a disturbing development for British shipbuilding firms. It calls for examination to establish causes and to find counter measures. No doubt shorter-term delivery dates are a powerful factor in sending orders abroad. But that factor is certainly not the only one operating. Many yards, particularly those in Germany, are also offering a fixed price contract which is attractive to prospective shipowners. Factors particularly affecting British shipowners have been the high rates of taxation and the lower present level of freight rates. It is, of course, possible if trade expands, that freights will become higher ; and the investment allowances provided in the Budget ought certainly to stimulate to some extent the ordering of new tonnage. But the major factor in retarding the placing of orders is, no doubt, the cost of British-built ships. If Britain is to obtain even her present reduced percentage of world tonnage it is very necessary that those costs should fall in relation to the earning power of the ships when built. Shipbuilders, of course, assemble components to produce an end product so that they are not able to control fully first cost, but there remains the possibility of the more efficient employment of labour, machines and material. Labour could certainly help by relaxing the rigid demarcation between trades, so avoiding stoppages, often over trifling matters, and the consequent loss of a large number of hours of work. Machines ought to be employed in useful work for longer hours per day, for it is manifestly wasteful to have capital locked up in equipment which is only in use for a small part of the day. That is an argument that applies to other industries besides shipbuilding. Shift working would not only solve this problem, but would speed up delivery, effect an all-round reduction in cost and the ships built would be making a contribution to the country's invisible exports at an earlier date. There are, of course, difficulties. But such arrangements are already in operation in shipyards abroad. Substantially increased deliveries of steel, promised for the present year, particularly of plate, would help to increase the annual rate of production and thereby decrease costs. But there are, too, other ways in which ships could be either reduced in cost or made more valuable profit earners for the same cost. A year ago the then Engineer-in-Chief of the Fleet advocated the development for mercantile use of lighter-weight machinery. Since then, in a more general sense, Sir Frederick Handley Page has pointed out that the use of advanced designs, even though utilising costly materials and costly manufacturing processes, may contribute, by lightening machinery in relation to its output and increasing its economy, to reducing its real cost. A study of the curve of maintenance costs suggests that it might be an economy to build lighter machinery, based upon a shorter life, and replace it at a later date with a propelling unit of more advanced design and improved thermal efficiency.

The emphasis of Viscount Runciman's remarks was upon the co-ordination of research. If building costs are to remain at the present high level—it is difficult to see how they could be substantially reduced—it is of paramount importance that the money invested by commercial and Government interests should be expended upon ships which are advanced and efficient for their particular services. Extensive research is going forward in this country and a large number of bodies, Government sponsored and private, are engaged in this work. The British Shipbuilding Research Association, for example, is engaged in a wide range of research upon the improvement in hull forms for merchant ships and specialist vessels. The " Lucy Ashton " experiments exemplify the work going forward on resistance. Investigations are being carried out on structural components to improve the overall efficiency of structures. Full-scale tests are being made to prove the reliability of scale model techniques. The question of corrosion, its cause and prevention, can never be forgotten, while in the province of the marine engineer work is proceeding upon water-tube boiler problems, and upon various aspects of diesel engine performance ; and data is being acquired about various machinery components. Vibration in both hull and machinery is one of many other problems now being studied. The development of gas and steam turbines is the province of the Parsons and Marine Engineering Turbine Research and Development Association, which carries out full-scale engine trials and designs prototype machinery to gain detail knowledge of both component and overall performance. Many other associations are engaged in research in other directions, many of which have some influence upon ship efficiency. Much of this research is of a long-term nature. But it would help if experimental results, when established, could be more speedily given practical application. However, before application, the advantages of new developments and discoveries should be subjected to an economic appraisal. For it is important to establish that the improvements embody simplicity of design, so that maintenance costs are not increased.

Obituary

HUBERT SCOTT-PAINE

We regret to record the death of Mr. Hubert Scott-Paine, which occurred at his home in Greenwich, Connecticut, at the age of sixty-three. Although he was one of the earlier pioneers of aircraft design and construction, he later specialised in the field of flying boats and high-speed marine craft design, the work for which he was most noted.

Scott-Paine was born on March 11, 1891, and after an eventful boyhood began the design of his first land-based aircraft in 1910. He first flew in that year and about three years later he constructed the first circular flying boat hull, and his patents for many other developments in flying boat design soon followed. He was one of the first to build a twin-engined land machine in this country and to build the first all-cabin aircraft. After the 1914–1918 war, Scott-Paine opened the first international flying boat service which operated between Havre and Southampton. In 1922 he financed and built the " British Challenger " with which this country won the 1922 Schneider Trophy. He was then the managing owner of Supermarine Aviation Works, Ltd., but in 1923 he organised and financed the British Marine Air Navigation Company. The following year this company was incorporated with Imperial Airways, of which he remained a founder director until 1940. Scott-Paine's interests were mainly directed to the design and development of high-speed marine craft towards the end of the 1920s. He founded the British Power Boat Company in 1927, and amongst the famous craft he designed, built and raced were the " Panther " I and II, and the " Miss Britain " class of power boats. Later came the designs on which were based the motor torpedo boats, gunboats and high-speed air-sea rescue craft used in the last war. Just before the war he established the Marine Design and Engineering Development Corporation in America and the Canadian Power Boat Company, Ltd., where these classes of craft are manufactured.

Literature

Applied Elasticity. By Chi-Teh Wang. London : McGraw-Hill Publishing Company, Ltd., 95, Farringdon Street, E.C.4. Price 57s. 6d.

The present tempo of life and the laws of supply and demand combine to shape the kind of men who come out from our universities. To-day, the demand in industry is for graduates who, with a minimum of training, can justify their salary in the shortest possible time. Inevitably, the universities meet this demand by forming specialists—graduates with an intimate knowledge of some particular aspect of engineering. To produce this readily utilisable material universities tend to teach students sets of rules rather than how to think. This is shown by the fact that most modern engineering textbooks devote almost as many pages to examples and exercises as to text. By doing this they hope to supply students with the answers to the problems they will meet later in practice without giving them a clear understanding of the principles on which they are based. Professor Wang does more than provide solutions to set problems ; he gives the general principles on which solutions must be based, and shows how, with engineering ability, the mathematical tool can be adapted to meet more cases than any textbook could include. Frequently a real knowledge of the physical behaviour of a structure with its mathematical correlations not only points to the solution, but also indicates the best design.

Applied Elasticity deals with the classical theory of elasticity and its numerous applications in structural engineering problems. The book comprises twelve chapters covering the analysis of stress and strain, equations of elasticity, plane stress-strain and torsion problems, finite difference equations and Southwell's Relaxation Method, the classical energy methods, the solution of problems

by means of complex variables, the theory of buckling applied to prismatic bars and to thin plates and lastly, the theory of shells and curved plates.

Professor Wang's approach to engineering problems is more fundamental than that of many Anglo-Saxon textbook writers; in this his approach resembles that of German and French authors. For example, the theory of buckling is, quite rightly, treated as a problem of equilibrium and not as a problem of strength of materials. The book will appeal to the more theoretically minded engineering student or physicist. It is well written and produced and should prove very valuable to all who wish to acquire a thorough grounding in the fundamental and classical theories of elasticity and to use their mathematical ability to practical purpose.

Metallurgy of the Rarer Metals. Vol. I: *Chromium.* By A. H. SULLY. Price 35s. Vol. II: *Zirconium.* By G. L. MILLER. Price 45s. London: Butterworths Scientific Publications, Ltd., 88, Kingsway, W.C.2.

THE appearance of this series of books on the rarer metals, under the general editorship of Dr. H. M. Finneston, is a matter of first-rate importance in metallurgy. The rarer metals, to which extensive attention is now being given, cannot, in the nature of the case, be made to occupy much space in general textbooks of metallurgy. Yet the importance of placing before students and practising metallurgists full information about them in compact and readable books of reference becomes increasingly apparent. In addition to the volumes on chromium and zirconium already published, books are promised in this series on manganese, molybdenum, titanium, tungsten and the platinum metals. The rarer metallic elements have this in common, that they can only with extreme difficulty be obtained in a useful form as pure metals, but two types are being dealt with in this series—those which are plentiful in nature or which, in the form of alloys often containing quite high percentages of the element, have wide and important applications in metallurgical industry, and those which are by no means abundant, but which have been used in metallurgical practice in relatively small percentages for the purpose of improving the mechanical properties of various alloys.

The first of these classes is represented by the metal chromium, and in his book on this subject Dr. A. H. Sully, who has been actively associated with research at the Fulmer Institute on chromium and chromium-rich alloys, has set a high standard for the series. The opening chapters contain an account of the history and occurrence of chromium, and of the production of various grades of ferro-chromium, commercially pure chromium and chromium of high purity. All available data on the physical properties of chromium are collected in Chapter 3. In these data, a fairly wide "scatter" is sometimes observable in the values recorded by different investigators, variations being often due to the use of metallic chromium prepared by different methods and of unstated purity. Melting point determinations are an outstanding example of this. In such cases, the most probable values are indicated after critical examination of the data. The physical properties of chromium show certain abnormalities, the most striking being the discontinuous change in several properties, such as Young's modulus, resistivity and coefficient of thermal expansion, which occurs at a temperature of about 37 deg. Cent. Although this is not explained, suggestions are offered for its further elucidation. Chapter 4 deals with the special technique necessary for the melting and casting of chromium and of chromium-rich alloys of high purity, the avoidance of this procedure by the use of powder metallurgy methods, and the workability of the products. Relatively pure chromium can be hot worked, but nearly all investigators who have worked with the purest chromium available to them have found it to be extremely brittle at room temperature. The brittle/ductile transition temperature is fully discussed. Whether the room temperature brittleness is inherent or due to minute traces of impurity is still an open question, but there are indications that under certain conditions chromium may show some degree of ductility at room temperature. Chromium-plating has been carried out commercially for many years and, naturally, Dr. Sully makes only a brief reference to practical procedure, but all interested in the process will derive benefit from a study of Chapter 5, which includes a discussion of the theory of chromium-plating and an account of the properties of chromium electro-deposits. Reasons for the high hardness of chromium deposits and the effect of heat-treatment are of great importance in connection with the development of relatively soft, machinable deposits and the improvement of the adhesion of the chromium coating. It is the severe differential thermal expansion at the coating/base-metal interface that limits the utility of chromium-plated steel at high temperatures. The gradient of composition produced by a diffusion process (chromising) enables components to withstand such stresses, and chromising has been successfully applied to steels and cast iron for many purposes, and especially to steels subject to corrosive attack at high temperatures. The theory and practice of modern chromising methods are described. The final chapter deals mainly with the constitution and properties of chromium-rich alloys. Many of these have outstandingly good resistance to oxidation and to deformation at high temperatures, but at room temperature they are invariably brittle. Moreover, even at high temperatures they are very sensitive to concentrations of stress due to minor imperfections. All alloys with enhanced strength have a higher brittle/ductile transition temperature than the pure metal. For these and other reasons, one is reluctantly compelled to agree with Dr. Sully that "the potentialities of chromium-base alloys as engineering materials are not at all good and the possibility of amelioration of their disadvantages is remote."

The second book of the series, *Zirconium*, by G. L. Miller, follows a similar plan; but, as zirconium production is rapidly developing, the space given to extraction and refining methods is correspondingly greater. Consumption of zirconium is, of course, small and world reserves have not been fully explored. The useful alloys so far developed have been those containing small percentages of the metal, such as the 0·7 per cent addition of zirconium to magnesium-zinc alloys. Uses of reasonably pure zirconium have been dependent either on its excellent resistance to corrosion or on its capacity for absorbing gases. The impetus to increased production and greater purity has arisen partly from competition with titanium (which it resembles in methods of production and in mechanical properties) and largely from the demands for material of low tendency to absorb thermal neutrons, in connection with the generation of power by nuclear fission. Hafnium, with which zirconium is invariably associated in nature, has a very much greater thermal neutron "absorption cross section," and, therefore, even a small hafnium content has a detrimental effect on the nuclear properties of impure zirconium. For this reason, the accepted value of the absorption cross section is continually being reduced and may be even smaller than 0·26 barn, the lowest value given in the book.

Stages in the development of the extraction and refining processes and the various methods for producing pure zirconium now in use or in the course of further development are ably described by Mr. Miller, who has himself been closely associated with the pioneer commercial production of high-purity zirconium by Murex, Ltd. Melting, casting and fabrication are also described in detail. The metal can be hot rolled, but not at a temperature above 650 deg. Cent., unless enclosed in a gastight steel sheath, on account of its pronounced tendency to oxidation. It can also be cold worked to form sheet and wire, and it may be welded, brazed or soldered by suitable methods. A wide range of zirconium-rich alloys has been investigated. Their equilibrium diagrams are reproduced and their constitution and properties are recorded.

Many of the reported properties of zirconium and zirconium-rich alloys show considerable variations due to differences in the purity of the metal under investigation. The data are presented after critical examination and with all possible accuracy. Chemical and mechanical properties are not affected by the presence of hafnium, so preliminary separation of this element may be unnecessary in zirconium for structural purposes. Its mechanical properties, however, are very similar to those of titanium, and it suffers from the disadvantage of a relatively high density, viz. 6·5 compared with 4·5 for titanium. The corrosion resistance, dealt with in another chapter, is in many respects superior to that of titanium, and this is likely to favour its use for certain purposes.

This book on zirconium, by a leading authority on the subject, has the quality of a comprehensive treatise, not only recording the present state of knowledge and practice, but pointing to future developments in what may prove to be a rapidly expanding industry.

Theoretical Naval Architecture. By EDWARD L. ATTWOOD and H. S. PENGELLY. London: Longmans, Green and Co., Ltd., 6–7, Clifford Street, W.1. Price 40s.

IT is good to see this valuable textbook in a new guise. Messrs. Pengelly and Sims have done well to revise the text for this new edition and to bring the volume up to date.

It is no exaggeration to say that this book in its various revisions since the first edition of 1899 has been a guiding influence in the training of large numbers of students in the schools, and of draughtsmen in the drawing-offices of shipbuilders and naval architects.

The essential form of the book remains as originally set forth, and this fact in itself is a considerable tribute to the wisdom of that eminent naval architect, E. L. Attwood, its first begetter. That the book still continues in the forefront of textbooks of naval architecture is a further tribute to the author, who is thus shown as a teacher of considerable standing.

One of its great merits as a textbook for students of naval architecture has always been the large number of examples to be worked by the student, given in the text and at the end of each chapter. Mr. Pengelly refers to this fact in paragraph 3 of his preface. Both he and Mr. Sims have held the chair of naval architecture at the Royal Naval College, Greenwich, and it can be fairly assumed that it is as a result of their

experiences in the academic field that they are agreed on the founders' policy in this respect and have even strengthened this feature in the present volume. All who have anything to do with the training of naval architects will agree with them wholeheartedly.

One naturally turns to the two new chapters, those on the Vibration of Ships, and of Merchant Ships, to find with gratitude the same clear, although necessarily brief, outline and treatment of the problems which has been characteristic of the book from its first appearance.

On pages 152 and 153 students are referred for further information on the stability of "The Captain" to *Naval Science*, Vol. I. The reference appeared as far back as the 1902 edition and possibly earlier, and it has always been a puzzle to one reader. Access by the general student to volumes of naval science cannot be easy; the volumes are certainly not readily come by to-day and probably never were. The further information sought for could have been equally well found in a much more accessible book—Sir William White's *Manual of Naval Architecture*. However, the reference is a reminder that there is a wealth of interesting information in the four volumes of *Naval Science*; and it may be that here is a field for an enterprising publisher to issue a volume of selections under a competent editor.

One minor misprint only has been noticed, and that is an unwanted "e" in Thornycroft, on page 417.

There are one or two points which should receive attention in the next edition, and, judging from its past history, a new edition will be required in the course of a year or two. It should be made clear that the Sir A. W. and Mr. Johns, referred to on pages 307, 308, are the same person; Mr. Gawn, to whom reference is frequently made, has attained the dignity of Doctor—possibly since the preface was written—and the Dockyard Schools have now become Dockyard Technical Colleges.

This review must end with best wishes for the continued prosperity of this grand old textbook.

Wilhelm Maybach. By KURT RATHKE. Friedrichshafen: R. Gessler K.G. Price D.M.20.

THIS very readable book is a biography of Wilhelm Maybach, who, together with Gottlieb Daimler, Karl Benz and others, belongs to that generation of ingenious designers whose influence on the early development of high-speed petrol engines and motor-cars is well recognised. The book which has the sub-title "From the Horse-Drawn Carriage to the Mercédès car" is, indeed, more than the life story of Maybach; it gives an interesting account of the combined effort of Daimler and Maybach, resulting in the construction of the first high-speed petrol engine in 1885 and its application in 1886 in a "horseless carriage." The author describes in detail the early history of the Daimler Motoren Gesellschaft (the present Daimler-Benz A.G.), the first successful participation of Mercédès cars in the Grand Prix and Gordon Bennett races against strong French competition in the early years of this century, and the part played by Maybach in materialising his own and Daimler's ideas, frequently against the opposition of strong conservatism displayed by his colleagues. We learn, sometimes with surprise, that many details of the modern automobile, such as the cellular radiator, the sliding mesh form of gearbox, the jet carburettor, &c., though not always entirely Maybach's original inventions, are at least his designs, adopted and modified to suit the requirements of the motor-car. The book, further, describes how Maybach at the age of sixty-one, after resigning from his position as technical director and chief designer of the Daimler Motoren Gesellschaft, designed the first suitable light engines for the airship of Count Zeppelin and eventually, together with his son Karl Maybach, founded a motor factory of his own, the Maybach Motoren Gesellschaft at Friedrichshafen, which became well known for its aircraft engines and light diesel engines. Wilhelm Maybach died in 1929 at the age of eighty-four, one of the few great engineers who lived long enough to witness the impact of his designs on the structure of society.

The Control of Quality in the Production of Wrought Non-Ferrous Metals and Alloys. I: *The Control of Quality in Melting and Casting.* Institute of Metals Monograph and Report, Series No. 15. London: The Institute of Metals, 4, Grosvenor Gardens, S.W.1. Price 15s.

THE papers presented at a symposium on the control of quality in melting and casting, held in London on March 25, 1953, have been reprinted with a full account of the discussion, and issued by the Institute of Metals as a special report. The science of quality control is developing rapidly and, in getting together those interested in its application to the melting and casting of metals, the Institute performed a valuable service to the industry. In this report are to be found papers on the principles of technical control in metallurgical manufacture, control of quality in the production of brass ingots and billets, in melting and casting copper and high-conductivity copper-base alloys, in the casting of zinc and zinc alloy rolling slabs and extrusion billets, in the melting and casting of aluminium alloys and of magnesium alloys for working.

There seems to have been some difference of interpretation of the word "control." In one paper it appears to be restricted to "error-operated control," which is effected "by arranging for the error to set in action a mechanism that will lead to a reduction of the error." By this standard very little can be done in melting and casting operations ("the only primary variable always controlled is the temperature of the metal . . . a depressing state of affairs"); though perhaps better opportunities of applying the same principle are afforded at later stages in manufacture. It would seem that control by responsible human agency, with all possible technical and instrumental aid, must remain essential in melting and casting operations. Fortunately, the theme of the authors in the main is an account of the steps taken, as a result of their investigations of the processes of melting and casting, to maintain and improve the uniformity and quality of their products at this stage, and so to reduce the chances of defects appearing at a subsequent stage of manufacture. Fundamental experiments to determine the causes of ingot defects, and factory trials to overcome them, combined with adequate supervision to ensure that the agreed procedure is meticulously carried out, have resulted in the very great advances made in the last thirty years in the science and economics of melting and in the quality of non-ferrous ingots. Thus the papers afford an extremely useful picture of present practice in the melting and casting of non-ferrous metals, illustrated not only by examples of ingot defects and other undesirable features of the casting process, but also by accounts of some of the outstanding advances in technique.

SHORT NOTICES

Gesammelte Berichte aus Betrieb und Forschung der Ruhrgas Aktiengesellschaft. Germany: Vulkan-Verlag, Wiesenstrasse 55, Essen. Price D.M. 12—This publication of the Ruhrgas Aktiengesellschaft comprises seven separate papers dealing with problems encountered in operating the gas grid. The report is well produced and is a useful contribution to existing literature. The first paper deals extensively with the engineering and economic factors to be considered in the design and operation of long distance gas mains, operating under pressure. Graphical interpretations and examples are used extensively to show the economic and operational factors involved. A portable calorimeter of novel design is described and test results are quoted. A description is given of a method for locating deposits in gas mains using a radio-isotope and the removal of naphthalene by melting with low-pressure steam. The causes of cracks in welded steel mains installed underground are considered in another report. High residual weld stresses appear to be a major contributory factor to failure, and low-temperature stress relieving by flame application with subsequent water cooling is recommended for the avoidance of this trouble. A case of excessive bearing wear with subsequent failure in a large electrically-driven gas compressor unit was found to be caused by induced electric currents arising from the electromagnetic action of unsymmetrical phase loading. Electrical insulation of the bearings remedied this trouble. A new method is described for the determination of the higher hydro-carbons present in coke oven gas that is claimed to be rapid and accurate. Finally, a new method for the evaluation of the efficiency of an experimental cyclone for dust removal is described.

Industrial Inorganic Analysis. By Roland S. Young. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 36s.—In this book, which is written with the object of meeting the requirements of the industrial analytical chemist, the elements are arranged in alphabetical order and under each individual element there are given some introductory comments, then an account of general analytical procedure, special procedures applicable to the determination of the element in alloys, ores and concentrates, and other commercial products and, finally, a list of selected references. A feature of the book is the attention given to mineralogical analysis and to the analytical requirements of the mining and ore dressing industry. For example, an appendix describes the analysis of xanthates, which find a place in the book owing to their importance in flotation processes. Other appendices deal with acidity tests for oils and pyranols, analysis of flue gases, and the chemical analysis of industrial and domestic waters. Not only are references to original papers given in the sections dealing with the individual elements, but at the end of the book about seventy reference books are listed, giving alternative or more detailed information on all aspects of the subject.

The book consists, for the most part, of suitably edited transcriptions of notes which the author has accumulated over a period of years, frequently giving useful hints on manipulative technique, and assessing the value of a method for general or specialised work. The recommended methods of analysis have thus been selected in the light of his personal experience. They are clearly described and the underlying principles explained. At a reasonable price, the book covers a wide range of industrial analysis, and should be of great value in giving the necessary breadth of outlook to advanced students of industrial inorganic analysis and in serving as a valuable work of reference for practising analysts.

BOOKS RECEIVED

Mathematics in Action. By O. G. Sutton. London: G. Bell and Sons, Ltd., York House, Portugal Street, W.C.2. Price 16s.

Statics and Strength of Materials. By R. H. Trathen. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 60s.

Stress Concentration Design Factors. By R. E. Peterson. London: Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 68s.

Institution of Naval Architects

ANNUAL SPRING MEETING

No. II—(*Continued from page 563, April 16th*)

THE meeting was continued on the morning of Thursday, April 8th, under the chairmanship of Sir Charles Lillicrap, with a paper entitled :

A NOTE ON LARGE TRAWLERS

By Professor Ir. H. E. Jaeger

SUMMARY

The paper considers in detail the design of trawlers of 165ft to 185ft in length having displacements between 1000 and 1300 tons and notes some of the deciding factors, such as range and speed. Most of the present-day trawlers are motorships and the influence of the draught and freeboard in the fully loaded condition is fully considered for this class of vessel. The values of freeboard-length ratios and the maximum draught aft are discussed and a number of formulæ are given as an aid to determining the principal dimensions. A section of the paper is concerned with stability and generally reviews changes in stability and gives some thought to the amount of righting moment at different angles of heel. It is suggested that the selection of the propeller is based on a compromise and solutions of the problem are offered, such as the controllable pitch propeller. The size of the fish hold is considered in conjunction with other factors, such as the amount of fuel and ice and the use of aluminium alloy components in the holds.

Discussion

Mr. de Rooij : Referring to the advantages of the controlled pitch propeller listed in the paper, I would like to state my experience in operating this sort of propeller. Generally, the officers aboard are inclined to alter the pitch of the propeller too frequently and too quickly. This implies that the installations might be damaged rather quickly and with trawlers there is the possibility that the fishing nets and hawsers might foul the propeller, which is always turning at the same speed. On the pilot ships of the Royal Netherlands Navy, of about the same dimensions as the trawlers and fitted with the same type of variable pitch propellers, the loss experienced for this propeller at full load is about 8 or 9 per cent compared with the optimum propeller. This loss is double the amount mentioned by Professor Jaeger.

Special attention should be given to the aft bearing of the stern tube and the diameter of the shaft, for the bending moment is much bigger than with the normal propeller. Probably this was the reason why in the beginning we had much oil leakage from the stern tube. One of the advantages of the controlled pitch propeller, given in the paper, is that towing speed is greater, so that more favourable fishing is to be expected. I believe the advantage of a higher towing speed is very relative, since at a speed greater than 5 knots the fishing nets will not stand the strain. The use of light alloy construction for the fish holds is interesting and I ask whether the slime of the fish would cause a chemical reaction with those alloys. Can Professor Jaeger indicate the best kind of glue to use for connecting cork slabs or isoflex directly to aluminium sheets ?

I believe that the diesel-electric system is ideal for the big deep-freeze trawler mentioned in the paper, especially as there are many auxiliaries aboard. It is appreciated that diesel-electric propulsion is not cheap ; but a controllable pitch propeller for about 1400 b.h.p. is also very expensive.

The factory ship project has not the typical silhouette of a trawler and the ratio of lateral surface to the surface of the ship above the load line is not so favourable as with the older types. Is this not dangerous in respect of wind pressure when putting out and hauling in the fishing nets ? There being no trim aft seems to me a disadvantage, because it will not be easy to keep the ship and the fish holds dry.

Mr. A. C. Hardy : I think Professor Jaeger is inviting us to think about fish factory ships, and I believe that we are on the eve of the evolution of an entirely new ship type—the fish factory—the first example of which will be on trial within the next few weeks. It is a question of whether these ships should be evolved from trawlers, which is rather Professor Jaeger's idea, or whether they should be new types. I believe the latter will be the case. The first specially built fish factory ship in the world, which is about to go on trials, is a completely new conception. It fishes by a stern chute, has the machinery amidships and the working deck is totally enclosed, and it has a direct-coupled, direct-reversing, opposed-piston oil engine. On the other hand, on the Pacific Coast of America there are many fish factory ships evolved from landing ships (tank). The naval architects have made use of the double bottom, side walls and the splendid sea-keeping qualities of those vessels and have used the deck, into which armoured fighting vehicles were put, as a fish deck. I believe the Russians have had ships built by Burmeister and Wain at Copenhagen, and which have deep freezing in their holds, and are about the same size as Professor Jaeger proposes.

About propulsion, we are in danger of trying to make medium and small-size motorships like motor-cars. The idea of making the main engines propel the ships and do everything else at the same time is wrong and will result in excessive maintenance bills. We have to hold to simplicity in propulsion.

I like the idea of the reversible blade propeller. It is possible to achieve a very good degree of control with it, and you can so adjust the pitch of the propeller as to give very nearly optimum conditions for running free and for trawling.

Monsieur E. R. Gueroult : On trawlers of 200ft in length we are faced with a difficult compromise in respect of the stability when the ship is light and when it is loaded, for if when light the GM is about 1ft we shall have too much stability when the ship is loaded. Regarding the big factory ships of the future, we feel that the design shown in the paper will probably be replaced by a larger ship on which fishing is done over the stern, using some method of fishing which will be closer to the American.

Professor E. V. Telfer : I am glad Professor Jaeger has given such a lot of references at the end of the paper, so that any who wish to acquaint themselves with what is known about trawler design can do so. About the design of the trawler, I would refer to Fig. 1 in the paper showing the relation of d/B and L/f for motor trawlers, and would ask how that has to be interpreted. There is a base of d/B ratio. As you increase that ratio you are presumably getting deeper forms and less stable forms. Then you see that the less stable form is joined up in a curve which coincides with forms having the least freeboard on a given length. What does that mean ? I suspect the whole diagram is purely statistical and must not be used as a guide for good design, and that if one were to use this one would get the worst stability associated with the least freeboard. I am quite sure that Professor Jaeger does not wish to convey that impression, and if he would deal with the point I should be grateful.

Professor G. C. Manning, in a written communication, said :

With regard to the very complete discussion on the stability of such vessels, it is my opinion that the most important stability consideration for such craft is the dynamical stability which is measured by the area under the statical stability curve. These vessels never get into trouble due to a static heel ; it is the force of wind and waves which cause their loss, when this occurs. In view of the fact that these vessels cannot have large freeboard, it is essential that they have a substantial value of the metacentric height, for otherwise the curve of statical stability will have small height and small breadth and, therefore, inadequate area. For trawlers of the size discussed in Professor Jaeger's paper, it would seem reasonable in the design to have the following minima in regard to stability, viz., metacentric height in all operating conditions not less than 2ft, maximum righting arm not less than 1ft at an angle of not less than 25 deg., range of stability 60 deg.

Mr. W. F. Spanner (in a written contribution) : In his consideration of the stability of trawlers the author has rightly laid special emphasis on the value of the metacentric height, which is the most important of the several factors which contribute to satisfactory stability. The value of the GM should be, in my opinion, not less than 1ft for a condition approaching extreme light with 10 per cent of fluids and stores on board. Such a condition, whilst not commonly met with in practice, may be taken as an " arrival condition " in the unlikely, but possible, case of a trawler returning without fish. A larger value may well be advantageous, giving some reserve. I think the calculation of the GM by Nickum's formula may well involve errors of appreciable magnitude, and that there is no substitute for a properly conducted inclining experiment when dealing with a matter so important as stability.

Little mention of trimming and ballast tanks has been made. I believe it is advantageous to provide forward and after trimming tanks of reasonable size to enable trim to be adjusted when necessary. Instead of solid ballast of concrete, which is not uncommonly found in these vessels, water ballast tanks have much to commend them. Such additions enable the vessel to be kept at sea in an optimum condition of seaworthiness at all times.

Professor Jaeger, in reply, said : Concerning the remarks made by Mr. de Rooij on the variable pitch propeller, that it is 8 or 9 per cent less efficient than the normal propeller, it is, of course, a question of experience. The optimum condition of the normal screw never arises. On the question of higher towing speed, I have in mind that with the variable pitch propeller we can increase from 3¼ to 3½ knots and perhaps from 4¼ to 4½ knots, but we shall probably never get more than 4½ knots. I know nothing about the slime from fish reacting chemically with the light alloy construction of the fish holds and can only say that aluminium alloy is used for this purpose throughout the world, so that I do not think the chemical reaction will be very dangerous. Further, I think aluminium alloys are the best materials to use where there are likely to be corrosive conditions, for aluminium protects itself. If, however, it is found that these reactions become dangerous, we can anodise the aluminium.

I would not advocate diesel-electric propulsion for a ship such as the big deep-freeze trawler I have illustrated. Mr. de Rooij has said that it is not cheap ; I would add that it is very heavy. On the point that the project has not the typical silhouette of a trawler, I would say that it has not advanced beyond the design stage, and have included it to give an indication of what can be done. I thank Professor Telfer for his remarks. I put the graph indicating the relation of d/B and L/f into the paper as a specimen, and as I have stated it might be used as a basis of approximation.

The next paper presented on Thursday morning was discussed jointly with the Institute of Marine Engineers, and was :

UNDERWATER TELEVISION : ITS APPLICATION TO THE SURVEY AND REPAIR OF UNDERWATER DAMAGE TO SHIPS AND INSTALLATIONS AND TO MARINE SALVAGE OPERATIONS

By Lieut.-Commander J. N. Bathurst, O.B.E., D.S.C., R.N.

SUMMARY

This paper briefly notes early development and goes on to enumerate some of the basic properties of underwater television, notably that it works at a lower light level than the human eye and can be used in depths down to 1000ft. The operations to locate the Submarine " Affray " are recalled and a short account given of the original equipment developed for the work, together with notes upon the various observations made with the aid of the gear. A brief description of an improved set is given and also subsequent experience gained using the equipment, while illustrations show the rig used for certain operations. The paper concludes with a few examples of the practical application of underwater television.

DISCUSSION

Mr. L. G. Stevens : Part of the work with which I am charged at the moment consists in damaging ships or targets by design, and sometimes even sinking them, and I feel that underwater television may be of considerable advantage in examining some of the results of our work. On a recent occasion we wanted to see what had happened to a target after successive explosions. We were faced with the question as to whether we should raise the target after each explosion, with the possibility of damaging it further in the actual operation of lifting, whether we should infer what had happened or whether we should rely on a diver, who might not be able to tell us exactly what we wanted to know. In such a case television would be extremely useful.

Looking to the future, to be able to see what is going on under water is often very valuable, sometimes more valuable to the research worker than the making of accurate measurements. It indicates the directions in which we should look for the explanation of some of our results. In the model field, developments in photography have been of the highest value ; if on the full scale we could observe what is happening with anything like the same facility it would be extremely useful. One direction in which it might be of great value would be in solving some of those problems of scaling which still elude us.

The author refers to the use of television for recording underwater operations by means of still or cine photography. I am not clear what advantage underwater television, used in association with cinephotography, has over the direct use of a cine camera submerged. I have not much knowledge of the receptive methods, but it seems that direct cinephotography would be likely to give better pictures than relaying them to the surface by underwater television and making the film there.

Underwater phenomena are unfortunately transient, and in that connection underwater television can help us. But where there are recurrent phenomena, such as that associated with the propeller or even underwater vibration, if we could have high frame rates with television, and if we could introduce something in the nature of stroboscopic observation, we might see what is going on. The problems of illumination and also of the set up would be formidable.

Professor E. V. Telfer : I feel that if we can devise a television camera to be part of the ordinary equipment of the tank truck travelling along the tank, so that we can prove any of the phenomena at will, we should be able to see what is happening not only on the truck, but we could have other screens in various offices to enable a number of people to examine the same things at the same time. If that is done there is probably a field for the cine camera ; but the first exploration, I think, is far better done by television. In the United States they have been developing a circulating water tunnel, and I think it has cost well over a million dollars, and it is a very expensive piece of equipment to run, because huge power is required to circulate the water. By having a television camera always available you might do with it what it has been thought could best be done in the circulating water tunnel.

Mr. G. MacNiece : We cannot sit down and think out what sort of underwater television camera to concentrate on without knowing what the application is going to be. Underwater television has been applied to oceanography and marine biology. The Scottish Marine Biological Association has been using a camera for about two years to study the habits of fish. In addition, we have carried out an expedition in which the oceanographers and biologists were enabled to study the sea floor at depths down to 4000ft.

I think the application to locks and docks must be treated with some care because, with very few exceptions, they are usually places where the water is extremely dirty. It is very disappointing, when people say they want to examine a lock or a dock, to have to tell them that this method probably cannot be used. That happened in the case of the " Empress of Canada " ; we were asked if we could help, but after one look at the water in the dock it was ruled out. In the future we may be able to do something about it with the clear water viewers and by other means, but those viewers are rather difficult to use.

On the technical side there is one point I may be able to clear up concerning the camera pick-up tube. It is very complex and difficult to use, but it gives high contrast sensitivity. That is very important under water, because invariably there is the equivalent of a mist or fog in water which reduces the contrasts of the objects, so that the tube, which emphasises the contrasts, is of great value. The mention of the slightly greater range of television is an academic point, and I do not think that in practice this can be put forward as an argument in favour of television. We regard television purely as an adjunct to the diver or salvage expert and do not in any way try to push it forward for use where other and simpler means could be applied.

Sir Stanley V. Goodall : I would like to strike a psychological note. My predecessor in the position of Director of Naval Construction once said to me that every time a submarine disaster had occurred he was not able to sleep for several nights. That indicates the burden which rests upon the naval architect and the trouble that may come to him when something has gone wrong with a ship for the design of which he has been responsible. I was responsible for the design of the " A " class submarines, and had passed that burden on to Sir Charles Lillicrap when the disaster to " Affray " occurred. While it is true that the examination made by this apparatus to a certain extent has given negative results so far in the case of the " Comet " disaster, it did set my mind at rest that some of the wild rumours that were circulated after that disaster were based entirely on conjecture and not on fact.

Mr. W. J. Ferguson : This is an extremely useful tool and its application will be of the greatest interest to the shipowner, the underwriter, the repairer, and the surveyor who is responsible for the recommendations before a ship goes to sea, in cases where ships suffer damage. Whether an underwater television camera is used or whether we use the normal procedure will depend on the availability and the cost of the television camera, and I ask whether we are likely in the near future to have the apparatus and trained people available at reasonable cost in any part of the world. Unless people know, it is very difficult to start. I can imagine the time when television cameras will be used extensively ; but a certain amount of propaganda will be necessary if we are to use this tool to advantage.

Dr. S. F. Dorey : May I ask whether the infra-red ray has been used for illumination where the camera has operated at depth in somewhat cloudy water ?

Lieut.-Commander Bathurst (in reply) : With regard to the use of the infra-red ray I hope I am correct in my statement that the scattering and diffusion is such that it does not give sufficient light penetration under water, although it is good on the surface. If I am wrong about that, Mr MacNiece is well qualified to correct me. As to availability and cost, television equipment is very costly and it needs an expert to maintain it. We are approaching the stage similar to that reached when radar was fitted in ships, where the firms concerned fitted their equipment and maintained it. The ideal arrangement would be for the manufacturers to build the equipment and to have it available at various ports in the world, or available for rapid transit to ports by air. With it would go the necessary technician to operate it, and the user would get the latest equipment which the manufacturers have in stock. I do not know how far manufacturers are prepared to go in having equipment and engineers scattered all around the world, but that is a commercial matter.

About the clear water container, the principle is to have a pack made with transparent plates which is filled with fresh water and attached to the front of the camera ; you have a sandwich or a cone of fresh water between the front of the camera and the object at which you are looking. Whereas without it the illumination gives a visibility of 3ft, for example, by using a clear water container you may be able to see to a distance of 9ft.

I am not in a position to answer the question concerning the use of a camera on the tank truck, but there are small cameras available. In such an application you will be working in clear water, and you can get a camera of dimensions about 10in by 5in by 5in. About cinephotography, in spite of what Mr. MacNiece has said, wherever we have used television under water under similar conditions to divers' observation chambers, I am convinced that we can see further with television. The television screen can be artificially brightened, and the light losses on the emulsion of the cine film are offset to a certain extent thereby.

(To be continued)

Rail Transport Wagon Shunting Machines

By J. G. LEE*

No. I

Nearly all British ports at which iron ore is imported use locomotives for shunting and hauling wagons. This article presents the advantages and disadvantages of other machines designed for this duty and estimates the relative numbers of these machines required with their cost. Recommendations are made as to which of these machines are suited to working an iron ore wharf.

At most British ports at which iron ore is imported, the method of shunting and marshalling the railway wagons is by locomotive. Considerable delays in the unloading of ships are sometimes experienced because the locomotive is unable to keep a sufficient flow of wagons to the wharf and at the same time perform the shunting duties on the wharf.

There are on the market mechanical shunters and pushers which are used extensively and with success at commercial docks and at railway yards performing duties allied to those at the iron ore ports. It is the object of this article, therefore, to present the advantages and disadvantages of these machines to the industry. One of the prime considerations before any new plant is installed is the cost of the equipment. The cost of operating each machine has therefore been estimated.

So as to be able to form a correct judgment of the most economical kind of machine to use an attempt has been made to ascertain how many machines of each type would be required to maintain a given unloading rate.

Available Shunting Machines

The machines being considered for shunting purposes are :—

(*a*) The petrol-driven truck mover (Figs. 1 and 2).
(*b*) The petrol or electric-driven shunting machine (Figs. 3 and 4).
(*c*) The electric capstan.
(*d*) The petrol shunting tractor (Fig. 5).
(*e*) The diesel shunting tractor (Fig. 5).
(*f*) The shunting locomotive.

In the following paragraphs a brief description of each machine with its advantages and disadvantages is given. The more general details are included in Appendix I.

* British Iron and Steel Research Association.

Petrol-Driven Truck Mover

There are two kinds of truck mover, one more powerful than the other. The smaller machine (Fig. 1) is fitted with a 420 c.c. side-valve air-cooled engine and is reputed to move 75 tons under normal conditions on level track. It has three forward gears and a chain drive. It runs on two flanged rubber-tyred wheels (one driven) on the same rail. There is a fitted sand box, which supplies dry sand to the rail at a constant rate during adverse conditions, and a special free wheel device protects the mechanism from damage should a down gradient cause the wagons to overrun the truck mover. The price is £275.

The large truck mover (Fig. 2) is of Continental design, but is manufactured in this country with a British-made J.A.P. engine. The load-moving capacity of this machine on a well-set level track is said to be about 150 tons. It is powered by a single-cylinder, air-cooled, four-stroke engine of 600 c.c. capacity. It has four forward gears, a chain drive and a free wheel system. Unlike the smaller machine, it operates on only one pneumatic-tyred driving wheel, which automatically balances the required pushing effort and the power of the machine. This unit is equipped with two auxiliary wheels. The estimated price is £425.

Accessories which can be purchased are a sand box to use under adverse conditions, an anti-flame device, a special pushing head for use on surbased wagons and a special gear ratio for use with very heavy loads.

Advantages.—Reports from users prove that these machines are ideal for shunting wagons in sidings where there is not much working room. They can be operated by one man, who, once he has got accustomed to the machine, can manipulate shunting operations with comparative ease. The machines are easy and economical to maintain. The wear on tyres is very slight. The large truck mover has been designed to run between two lines of wagons, giving it an added advantage.

Disadvantages.—The open construction of the machines makes them vulnerable, in the author's opinion, to damage from the arduous working of iron ore wharves. Although it is claimed that the wagon pushers run along the rail, experience has proved that it is difficult to keep it on its course, especially when working over bends. Considerable time can be lost in shunting if the pusher is frequently being derailed. At one yard the practice of working along a rail has been abandoned, except when breaking a train, and because there is not sufficient travel in the ram to support the wagons from the ground a path of sleepers has been laid between the rails from which work is carried out. Because of the low speed of the smaller machine, it would be impracticable to use it on wharves where the shunting distance was great. Consideration must also be given to the operator who is liable to fatigue if expected to handle large tonnages over long distances with either machine.

Petrol or Electric Shunting Machine

These machines are manufactured on the Continent, but can be purchased in this country at a cost of about £706 for the petrol version and £1000 for the electric, to which must be added the cost of shipping from the Continent.

The petrol-powered machine (Fig. 3) is fitted with a Volkswagen air-cooled petrol engine developing about 25 h.p. The electric-powered machine (Fig. 4) is driven by batteries having a potential of 76V, fitted in four units, also developing about 25 h.p.

The load-moving capacity is rated to be between 100 tons and 120 tons on a straight level track. Both models run on pneumatic tyres and therefore must have a relatively firm surface built up between and alongside the track to rail level from which to work. Little else is known about either model of the shunting machine, but from data which have been compiled views can be passed on the machine's usefulness.

Advantages.—The machine being independent of rails is more manœuvrable than those which run along the rail. When pushing, once the operator has got a train of wagons moving, his only task is to keep the

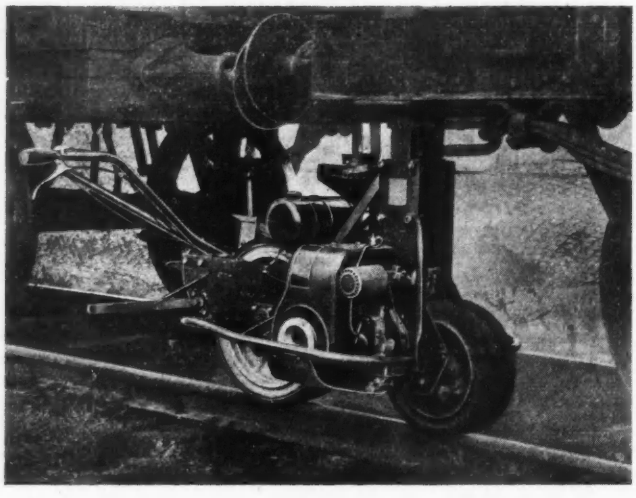

Fig. 1—Small Truck Mover—Capacity 75 Tons

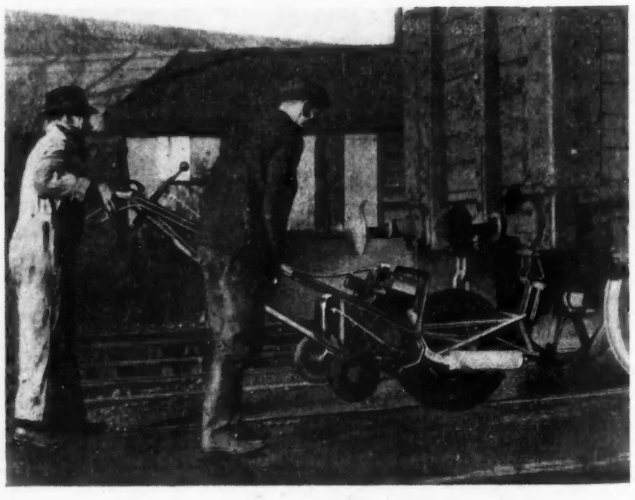

Fig. 2—Large Truck Mover—Capacity 150 Tons

machine on its course. This saves the operator considerable fatigue. Since the machine can push or pull, wagons can be shunted without the machine having to move to the other end of the train.

Disadvantages.—The low speeds and the comparatively low pulling capacity of this machine make it unsuitable for moving wagons any distance from the wharf. Provision will have to be made for charging the batteries of the electric model. At a dock where this model is in service about twice the required number of machines were purchased, half being in service while the other half were having their batteries charged.

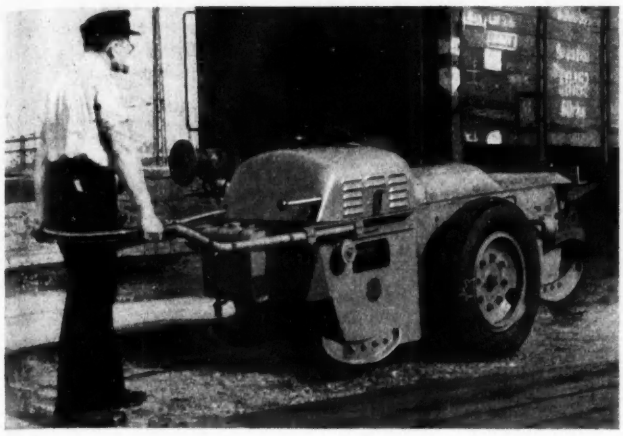

Fig. 3—Petrol Two-Wheel Shunting Machine—Capacity 120 Tons

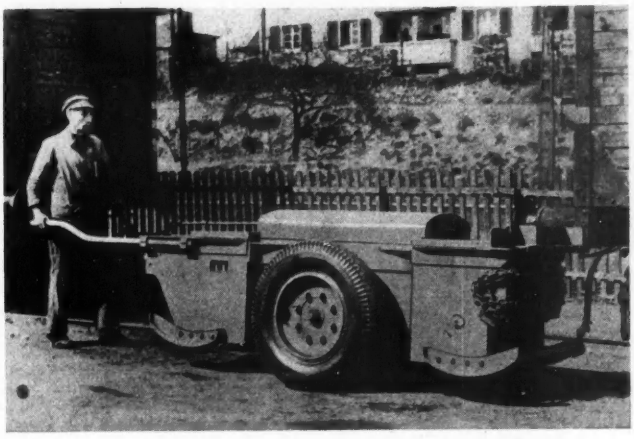

Fig. 4—Electric Two-Wheel Shunting Machine—Capacity 120 Tons

Electric Capstan

For the capstan to be a practical proposition on a wharf it is assumed the electric power is readily available.

The pulling capacity of capstans available on the market is within the requirements of any iron ore wharf. The cost of a machine varies as the pulling capacity.

The motor and controller are sunk into a pit, which is easily accessible for inspection and maintenance.

Advantages.—To have capstans situated at vantage points along the wharf does ensure that shunting facilities are always available, thus reducing possible unloading delays from this source. The running and maintenance costs are low.

Disadvantages.—Wagons can only be pulled towards the capstan. To pull a train of wagons past the capstan fairleads will have to be used. The lengths of wire used restrict the free passage of the wharf when shunting is in progress ; they add to the general untidiness of the wharf when not in use, and increase the possibility of accidents.

Petrol and Diesel Shunting Tractor

Considerable time has been spent watching these machines at work at commercial docks and railway sidings. The class of work they can undertake varies from shunting wagons to moving cranes and ships along the berth. The models of two manufacturers have been considered.

Both petrol and diesel machines are based on the Fordson Major tractor. The diesel tractor is powered by a four-cylinder Fordson diesel engine developing a maximum of 42 b.h.p. at 1750 r.p.m. An alternative four-cylinder Fordson o.h.v. petrol or t.v.o. unit with similar output is available. Alternative methods of ballasting the machines are with water ballast in the rear tyres, ballasted hubs to the rear wheels, or a ballast compartment on each side of the driver's cab above the rear wheels.

On the latest machines foot throttle is standard, coupled with a governor on all machines. The latest Fordson units, both petrol and diesel, incorporate electric starting.

There are minor differences between the models marketed by the two manufacturers, such as the braking arrangements and body design.

It is claimed by one manufacturer that the tractors are capable of crossing over rails. Although this is true of both makes, it would be difficult for the driver to control the wagons being shunted while his tractor is working under these conditions. One commercial dock where there are no built-up roads alongside the railway lines has overcome this problem by tipping wagon loads of ash in the 4ft way, thus building up the road to rail level. Where points and crossings were encountered it was necessary to timber these first.

Tyre life depends largely on the care with which the tractors are handled. At a dock where machines have recently been installed considerable trouble has been experienced from tyre damage, which is due to the inexperienced driver running over the sharp rail sections at points. At another dock and at railway yards, however, tyres have been used for periods as long as five years.

The main difference between petrol and diesel tractors is one of economy. Although the initial cost of a diesel tractor is higher (£975 for diesel model and £850 for petrol model), the fuel consumption is less, and, assuming the tractor is used on private property only, rebated fuel oil can be purchased at about 1s. 4d. per gallon, compared with 4s. per gallon of petrol.

Advantages.—For shunting duties, as required at an iron ore wharf, these machines are reputed to be more practical than any other method. Their speed of operation and their being independent of rails enables them to perform a greater number of shunts than any machine so far described in this report.

It is possible for them to marshall wagons at various points on the wharf without fatigue to the operator.

Disadvantages.—Probably the greatest disadvantage is the fact that the road has to be built up to rail level.

Shunting Locomotives

The locomotives being considered are :—

(1) The diesel mechanical locomotive of about 150 h.p.

(2) The diesel mechanical locomotive of about 300 h.p.

(3) The diesel electric locomotive of about 350 h.p.

(4) The steam locomotive of about 350 h.p.

The small diesel mechanical locomotive has a pulling capacity of about 500 tons. Provided this machine is not overloaded, it will prove to be economical. Like the other shunting machines, it should be confined to the duty for which it was acquired.

The diesel mechanical locomotive reaches its upper limit at about 300 h.p. (about 1400 tons pulling capacity). Larger machines of this class can be purchased, but they require special gearboxes, which will increase the cost above that of the diesel-electric locomotive of the same size.

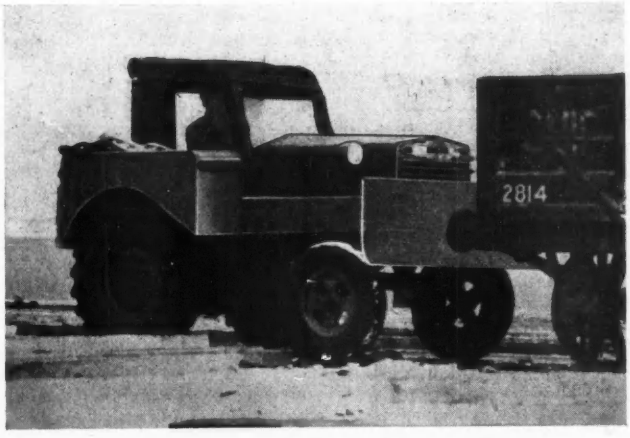

Fig. 5—Shunting Tractor—Capacity, Petrol or Diesel, 200 Tons

The diesel-electric locomotive comes into its own at about 350 h.p. (about 1500 tons pulling capacity). Smaller machines of this type are not manufactured.

At docks and at steel works it is not usual practice to purchase locomotives to suit the varied duties. The allocation is made from a pool of steam or diesel-electric locomotives, which are of the order of 350

h.p. It is thus ensured that the heaviest duty can be encountered.

The comparative merits of diesel and steam locomotives have been discussed at length in other papers, [1, 2] so it is not proposed to cover them again.

Availability, however, is the one distinct advantage of the diesel over steam which must be mentioned here. It has been said that one diesel can do the same amount of work in a given time as two steam locomotives. At a wharf where the fuelling station is some distance away, considerable delays in unloading can be experienced while the steam locomotive is being serviced. These delays could be avoided by using a diesel or two steam locomotives.

The heavy initial cost and slightly greater maintenance costs of the diesel locomotive has to be given thought, although the running costs are more economical than for steam engines. Fuel costs in a diesel locomotive will be very much less than the steam because of the low cost of diesel fuel oil compared with coal and the fact that the diesel can be shut down when not in use, whereas the steam engine will always have to be in steam ready for when it is next required.

Advantages.—Speed and haulage capacity are probably the greatest advantages of the locomotive.

Disadvantages.—At a wharf where the shunting distance is short the locomotive loses its advantage of speed, since it is no faster in collecting and delivering wagons than most other machines, and the distance is not sufficient to make use of its high speed.

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(*To be continued*)

Employment of the Elderly

By L. BAGRIT*

It is well known that the proportion of elderly people in Britain's population is increasing. It is therefore desirable to retain in industry active people long past retiring age. Many people well over sixty-five strongly desire to be employed. The problem is to find for them work that they are fitted to do. Here Mr. Bagrit tells what his own firm has done to meet the situation.

THE gradual ageing of our population underlines two specific employment problems. First, we may seriously have to tackle the prejudice which makes it often difficult even for highly trained men of over forty to find new employment. The second problem is to find suitable jobs for men and women who are near retiring age but under modern conditions are perfectly capable of some further years of work in less exacting jobs, and there are some such jobs in nearly every industrial undertaking. In this brief report I am concerned with the second question. In our company we have a lengthy tradition of long service and have generally encouraged physically fit employees to stay on at work even after normal retiring age. About four years ago we decided to take a further step, namely, to assess what categories of jobs could be performed by elderly people and actually to recruit elderly workers of both sexes to fill specific vacancies in these categories. This assessment was not difficult since we had already surveyed all the jobs in the firm in connection with the employment of disabled persons, and from this information it was comparatively simple to earmark jobs which appeared suitable for older workers.

The range of such jobs turned out to be wider than anticipated. To the more obvious class of job such as labouring, stores, maintenance and inspection, were added jobs like postal messenger, prototype maker, and certain precision fitting work where great accuracy and quality of work were more important than quantity. The reserving of such jobs for older workers brought two tangible advantages. It often meant that we could use younger employees for more important work. At the same time, as some of our older workers gradually became incapable of effectively carrying out the duties on which they were engaged, we could offer to transfer them with their agreement to less exacting work, sometimes involving lower rates of pay, which were, however, in all cases accepted with good grace.

So far the policy has run smoothly. At our Lewisham works, where of our total of 3500 employees we have a strength of about 1300 (850 men and 450 women), we are to-day employing seventy-two men of sixty and over and twenty women of fifty-five and over, all in all with satisfactory results. Of the seventy-two male "over sixties," forty-eight are manual workers, twenty-four of them being skilled, six semi-skilled and eighteen unskilled. The skilled are engaged on such jobs as milling and other machining, instrument-making, inspecting, fitting and in the foundry. The semi-skilled are in jobs like metal polishing, store-keeping and packing, and such simple machining as drilling. The unskilled are labourers, night watchmen and car park attendants. It is significant that no less than twenty-three of the forty-eight have been engaged by us during the last three years, including seven skilled and six semi-skilled men. On our staff side we have twenty-four men of sixty and over employed as foremen, draughtsmen, progress and planning engineers, &c. Of these, six have been engaged in the past three years as wages clerk, shipping and despatch clerk, postal messenger, senior inspector and sales representative. Of the twenty women of fifty-five and over we have seven in the factory as assemblers, storekeeper, packer, cleaners and cloakroom attendant, five of them having been engaged in the past three years, while the other thirteen, three of them recently engaged, are on the staff as shorthand typists, clerks and State-registered nurse in charge of the surgery.

An instructive case among elderly men happily settled down in work novel to them is that of an ex-schoolmaster of no less than forty-three years' standing, who, for the past eighteen months, has been employed on testing delicate instruments. Having been a science master, he had the necessary background and his patience and painstaking attention to detail are an example to much younger men. Another man, aged seventy-one, before coming to us employed on various stores and clerical jobs, is to-day doing an excellent job as wages clerk, even though new to wages work. On a higher level we have a former executive in a chemical engineering company now working effectively for us as sales quotation engineer dealing with customers' inquiries and quotations. Perhaps the most remarkable case is that of a valued member of our sales staff who was seventy-one years of age when we engaged him five years ago, but whose contacts and wealth of knowledge have been a consistent asset to us. On a different level we have an ex-manager of a billiards hall now contentedly doing light labouring work such as sweeping and fetching and carrying components in an assembly section. Among our elderly women employees we have a full-time worker who has been in the factory for forty-six years and is still on the bench, and a shorthand-typist of equally long service who at the age of seventy-one still does a fair quota of work for us, even though no longer working full hours.

When we launched our policy there were one or two misgivings that veteran workers might object to lower scales of pay for less demanding work, but we have experienced no trouble on this score. Nor did we come up against any real difficulty over pensions, either with our own or newly recruited older workers. (Our own staff pension scheme admits eligible male employees up to sixty-four and a half years of age and female employees up to fifty-nine and a half years of age. At the moment we do not operate a pension scheme for manual workers, but the individual circumstances of retiring long-service employees are reviewed and *ex gratia* pensions generally approved by the company.) Indeed, among the newly recruited, some staff employees are already drawing superannuation from a previous firm but have either found this inadequate or, as is often the case, have preferred the interest and companionship of a job to the dullness of retirement. Much the same motives induce a number of elderly manual workers to continue to work rather than make do on a State pension.

To sum up: in a firm like ours, with the bulk of its labour force youthful and vigorous, the employment of elderly men and women for periods of some years (usually two to five) past retiring age, must have fairly narrow limits. Yet within these limits useful results can be achieved. Not, of course, without deliberate effort. To broaden the scope for employing older workers it will usually be necessary for the personnel department of a firm to consult with factory management on reassessing appropriate jobs and to keep in close touch with the local labour exchange in order to recruit suitable elderly workers, a task demanding both tact and confidence in the whole idea. The effort, however, may be well repaid. In our own firm we have been particularly impressed with the attendance record of our elderly employees. We have found them extremely conscientious, starting work promptly on time and needing the minimum of supervision. Equally important is the gain in social and human terms. By giving them the chance to continue work in special, appropriate jobs, veteran workers can be made to feel that they are still perfectly respected members of an active organisation and giving service of value to the company and in terms of overall production to the nation.

In conclusion, although what has been done in our firm is as yet only an experiment of a few years, results indicate that a nation-wide drive for the wider employment of elderly people in industry might be of considerable value.

* Managing Director, Elliott Brothers (London), Ltd.

Reversing Cold Strip "Y" Mill

(By Our American Correspondent)

AN interesting 20in reversing cold strip rolling mill designed and built by the Mackintosh-Hemphill Company, of Pittsburgh, Pennsylvania, has been installed and is now in full production at the works of the Société Etilam, at Jeumont in France. The mill, which is shown in the accompanying illustrations, is used generally to reduce Thomas steel strip from 2mm to 0·5mm in widths from 300mm to 400mm at speeds up to 1200ft per minute. This reduction is accomplished in four or five passes, with average pass reductions in a range of 25 to 30 per cent.

The seven rolls in this so-called " Y "-mill are arranged in the form of the letter " Y," which gives the mill its name. One driven work roll is situated beneath the strip and is supported along its entire body length by a back-up roll. These two lower rolls, carried on housing screws, may be adjusted up or down in the roll housing, as required by the thickness of the strip. Above the strip, and directly over the lower work roll, is a " V "-shaped group of five rolls. The bottom roll in this formation is a " baby " work roll. Contacting and driving this small roll on each side at a 45 deg. angle from the vertical, and forming the upper legs of the " Y," are two intermediate rolls, each of which is supported by its own back-up roll. The top intermediate rolls are backed up and stiffened by large back-up rolls, which are of great enough diameter to resist distortion. The maximum roll diameters of the mill are listed in the following table :—

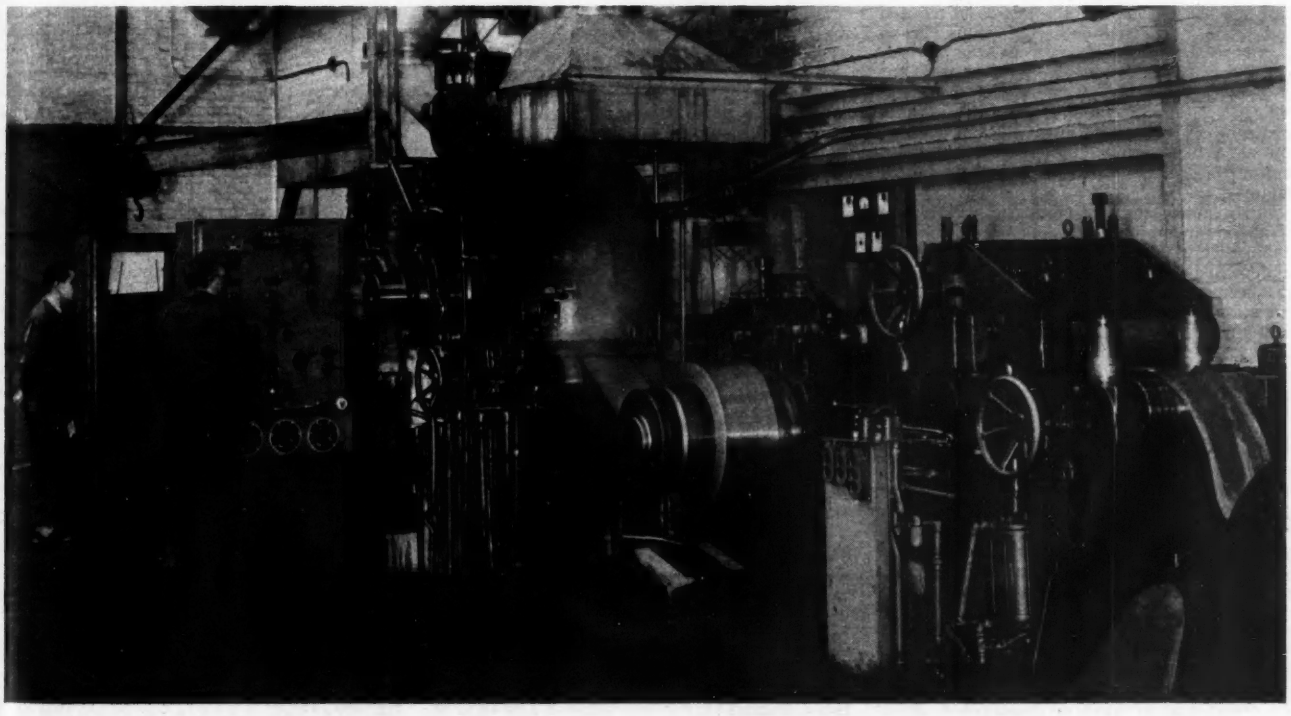
Lower work roll (driven)	6½in
Lower back-up roll	19½in
Baby (work) roll	3½in
Two upper intermediate rolls (driven)	6½in
Two upper back-up rolls	17½in

The 20in " Y "-mill was designed for a total separating force, or rolling load, of 720,000 lb, equal to 42,500 lb per inch of width in rolling full 17in wide strip with an equivalent work roll diameter of 4in. Because of its three-high principle of construction, the mill has been found to provide great rigidity against horizontal deflection of the work rolls. Both top intermediate driven rolls being placed at an angle of 45 deg. from the vertical on either side of the baby roll, brace the baby roll against the rolling forces which tend to distort it. The top work roll of the 20in " Y "-mill has a nominal diameter of 3in, and the bottom work roll a nominal diameter of 6in. A standard four-high mill having the same separating force and the same penetrating ability would require a pair of 4in work rolls. Since the resistance to horizontal deflection is a function of the fourth power of the roll diameter, this resistance in the bottom work roll of the " Y "-mill is thus more than five times as great as that of an actual 4in diameter roll in an equivalent four-high mill. In rolling, the " Y "-mill is claimed to require only enough tension to keep the strip flat, as the torque input of the mill is sufficient to enable the work rolls to perform all the necessary work in rolling the strip. The possibility of strip breakage is thus greatly lessened and the upper limit on percentage of reduction per pass is increased, particularly when reducing the lighter gauges of strip.

The housings of the " Y "-mill are heavy steel castings, face machined all over. The housing windows are machined to receive roll chocks, and all window surfaces are provided with precision liners. The top rolls are carried on cross bridges which support the weight of the roll and chocks and which clamp the upper back-up rolls securely in place in the windows. Shim groups are used between the tops of the back-up chocks and the tops of the windows to compensate for change in roll diameter after grinding. Each upper back-up roll is roller bearing supported in steel chocks, with rocker plate provision for bearing protection. The two upper intermediate rolls and the baby roll are supported on hydraulic cylinders located in the lower work roll chocks, to maintain roll contact when threading the mill, or when idling without strip between the rolls. The intermediate driven rolls and lower work roll are anti-friction bearing mounted in steel chocks which are sealed for protection. The baby roll, because of its minor radial neck loads, is carried on enclosed sleeve bearings fitted with anti-friction thrust bearings. The lower work roll and both upper intermediate rolls, all of which are driven through universal spindles, are ground with matched diameters. All back-up rolls are of forged steel, with body hardness of approximately 80 to 82 Shore. The driven rolls are of forged alloy steel, heat treated to approximately 86–88 Shore hardness. The baby rolls are high alloy steel forgings, heat treated to a Shore hardness of about 88–90.

The lower work roll and back-up roll are adjusted up and down on non-rotating housing screws by means of a rotating screw box integral with the low speed worm wheel. The entire mill separating force, transmitted through the housing screws to the rotating nuts, is carried by tapered roller pure thrust bearings. The complete housing screw assembly is built as a unit

Roll Arrangement of " Y " Mill



Entry Side of " Y " Mill

and, if necessary, may readily be removed from the roll stand for servicing. All screw-down parts are designed so that the rolls may be forced into the strip. An individual motor operates each screw, with the power transmitted through a gear reducer and worm wheel units. The lower work roll and the two upper intermediate rolls are driven through universal spindles by a completely enclosed set of three pinions, the lower pinion being directly coupled to the main mill motor. The electrical equipment for the mill was supplied by the German A.E.G. Company. The main mill motor has a 600 h.p. rating and is directly connected to the three 6½in diameter rolls. The mill as well as the 200 h.p. coiler drives are controlled by a variable voltage control system to provide continuous speed adjustment from a low threading speed to any desired running speed. The mill motor develops constant torque from 0 to 600ft per minute and constant h.p. between 600ft and 1200ft per minute strip speeds. The proper basic speed relation between the mill and the coilers is obtained by means of rotating regulators operated from a tachometer generator directly driven by the mill motor and varying the voltage of the coiler drives in proportion to the mill motor speed.

Physical Society Exhibition

No. III—(*Concluded from page 577, April 16th*)

WE learn from the Physical Society that the annual exhibition of scientific apparatus which ended on Tuesday, April 13th, is the last to be held at the Imperial College of Science and Technology. A statement from the Society explains that despite the continued co-operation of the rector and governors of Imperial College, the space which can be made available for the exhibition is continually diminishing. Accordingly, the Society has decided regretfully to sever the long and cordial association of the exhibition with the College. Arrangements are being made to hold the next exhibition in the Royal Horticultural Hall towards the end of April, 1955. It is intended that the exhibition should preserve its present character and should continue to encourage the development of scientific instruments and apparatus.

Here we conclude our descriptive review of some of the equipment seen at the recent exhibition.

Cinema Television, Ltd.

A flying-spot microscope, the first production model developed from the prototype shown at last year's exhibition (The Engineer, April 10, 1953, page 537), was shown by Cinema Television, Ltd., Worsley Bridge Road, London, S.E.26. Compared with the prototype the production model embodies a number of improvements. For example, the number of picture elements has been increased from 133,000 to 165,000. By adopting diagonal sequential scanning future conversion to a scanning counter has been facilitated; the bandwidth has been reduced and better definition obtained, thus giving improved signal-to-noise ratio; a new video amplifier has been designed with an input/output characteristic which is variable to provide five different gamma values—unity, two values greater than unity and two values less than unity; a black-level clamp is incorporated to ensure the correct operation of the variable gamma amplifier.

Other improvements include the stabilisation of all power supplies, the adoption of a focus stabiliser and tube protection unit, &c. The equipment is still in desk form, but the layout has been adapted to facilitate greater ease of operation.

Briefly, the specification of the flying-spot microscope is: magnification, 350 to 6400; resolution, 0·25 μ; optical microscope, Baker type "4AQ"; number of lines, 700; aspect ratio, 1 : 1.

Kelvin and Hughes, Ltd.

A new design of echo sounder, known as the "Kingfisher," for detecting shoals of fish was shown by Kelvin and Hughes (Marine), Ltd., 99, Fenchurch Street, London, E.C.3. The complete equipment is a combination of an electrolytic recorder (Fig. 8) and a viewing unit (Fig. 9) embodying a cathode-ray tube.

With this equipment accurate soundings are obtained by projecting supersonic sound impulses downwards towards the sea bed and measuring the time taken by the reflected echoes to return to the ship. The echo signals are presented to the observer as recorded or visual traces which can be read off against suitable calibrated depth scales. The recorder can, if desired, be used independently. It presents a continuous and accurate outline of the sea bed profile with a constant indication of depth. At the same time it gives well-defined traces of fish shoals and other submerged objects between the ship and the sea bed.

The viewing unit, or scale expander, can be used to scrutinise any selected 15-fathom, 10-fathom or 5-fathom layer of water beneath the ship. It is particularly suited to the detailed study of fish shoals close to the bottom. The visual display is greatly expanded so that it is possible to portray a 5-fathom layer of water on the 5in viewing screen. This enlarged presentation on a scale of 1 fathom to 1in simplifies the task of carrying out a detailed examination. The "Kingfisher" echo sounder is available in

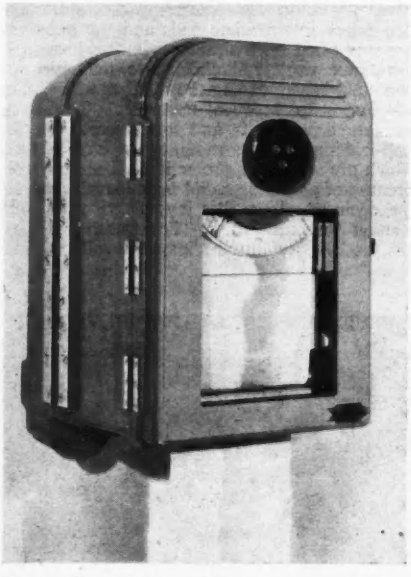


Fig. 8—Electrolytic Recorder for Use with Fish-Finding Echo Sounder—Kelvin and Hughes

two forms, with scale ranges giving a coverage of 0 to 180 fathoms or 0 to 240 fathoms respectively.

A frequency of 30 kc/s is used for the transmitted sound impulses, which are generated in a pair of magnetostriction oscillators, each mounted in a parabolic sound reflector and housed in a separate steel tank welded to the inside of the ship's hull. The chart record is produced by an electrolytic recorder on impregnated moist paper in the form of a sepia trace on a white background, with a 5in wide scale graduated in minutes. Equipments are available for use on 24V, 32V, 36V, 110V or 220V supplies, with power consumptions of 200W to 300W, depending on the supply voltage.

On the same stand Kelvin and Hughes (Aviation), Ltd., New North Road, Barkingside, Essex, arranged a demonstration of a method of reducing the effect of friction in ball races. The principle of this demonstration is that by

Fig. 9—Viewing Unit of Fish-Finding Echo Sounder—Kelvin and Hughes

rotating the inner races of a pair of ball bearings in opposite directions the friction torque reaction on the outer races is effectively cancelled out except for the difference in the r.m.s. values of the friction torques. This difference may be further reduced by reversing the direction of rotation of both inner races at a period dependent on the inertia of the system carried by the bearings.

In this demonstration a pendulum was suspended on two ball bearings which were end-loaded with a pressure of several pounds and had their inner races mounted on rotatable spigots. Because of the friction of these races the pendulum quickly came to rest after being set swinging. When the inner races of the bearings were rotated in opposite directions, however, the pendulum oscillations continued for some minutes.

It is envisaged that a system using this principle might be applied to gyroscope gymbal bearings with three main advantages: first, considerable reduction in the level of the friction torque; secondly, elimination of the effects of torque peaks by increasing the relative speed of inner and outer races, and, thirdly, reduction of the unbalancing effect of accelerations due to the play necessarily left in the conventional gymbal assemblies.

Metropolitan-Vickers Electrical Company, Ltd.

An electronically excited, high-temperature fatigue apparatus was exhibited by Metropolitan-Vickers Electrical Company, Ltd., Trafford Park, Manchester, 17. This equipment consists of a variable-frequency oscillator, with an amplifier (for frequencies of 19 to 450 c/s in two ranges), feeding a moving-coil electromagnetic drive which vibrates a specimen arranged as a cantilever clamped at one end and supported on a base plate. The specimen is mounted in a tubular, electric resistance furnace designed for temperatures up to 750 deg. Cent. The amplitude of vibration is proportional to the applied stress and is measured by a magnifying eyepiece provided with an internal scale. An automatic trip switches off the oscillator when fracture of the specimen begins.

Another exhibit was the "MS3" mass spectrometer, which is basically similar to the one shown at the 1951 exhibition, except that the new version of the equipment is adapted for electromagnetic scanning and is provided with an automatic recorder unit with automatic range changing. The instrument is therefore suitable for analysis of gas mixtures, including hydrocarbon gases. The mass range of 1 to 72 can be scanned using the full ion-accelerating voltage of 2000V; higher masses can be focused by reducing the

ion-accelerating voltage. The instrument is also suitable for isotope abundance ratio determination in the low mass range, by the double collector or single collector method employing manual operation.

The mass spectrometer is housed in a cubicle approximately 44in wide by 24½in deep by 69½in high ; the dimensions of the recorder cubicle are approximately 22in wide by 24½in deep by 60in high. The controls have been reduced in number as far as possible and the equipment has been successfully operated by specially trained process operators.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

The Building Research Station, the Fuel Research Station, the Hydraulics Research Station, the Mechanical Engineering Research Laboratory, and the National Physical Laboratory were represented on the stand of the Department of Scientific and Industrial Research, 5–11, Regent Street, London, S.W.1.

The Hydraulics Research Station showed a series of small propellers and two alternative electronic units developed for measuring a wide range of water velocities in hydraulic models. The propellers, machined from polystyrene rod, were freely suspended between conical jewel bearings supported by a stainless steel bracket or alternatively a " Perspex " tube. The electronic units measured the angular velocity of a propeller without introducing additional mechanical load, permitting measurements of very low water velocities. One unit measured, by means of " Dekatron " counter tubes, the time required for a definite number of propeller blades to pass a fixed point. In addition, a milliammeter showed the velocity on a logarithmic scale. The other unit indicated the velocity on a linear scale.

The Mechanical Engineering Research Laboratory demonstrated the phenomenon of emission from worked surfaces. Freshly abraded surfaces (and evaporated films) of certain metals, such as aluminium, zinc or cadmium, when placed under an open-ended Geiger-Müller counter, and illuminated with light of a definite wavelength within the visible range, emit negatively charged particles which trigger the counter and are recorded as pulses on an oscilloscope and scaler. It is believed that electrons are liberated from electron traps, probably negative ion vacancies (F-centres), present in the surface oxide, by the action of light and thermal agitation. In the presence of oxygen, oxygen molecule ions (O_2^-) are formed and, by means of a positively charged grid, they are directed into the counter. The phenomenon can also be recorded photographically, since the electrons cause the formation of traces of hydrogen peroxide, which produce an image on photographic plates.

The exhibit showed a horizontal counter operating in an air-alcohol atmosphere, at 10cm Hg and recording pulses from an abraded metal specimen under the action of light. Photographic records were shown of cleaved single crystals of zinc, which, only when abraded, produce an image.

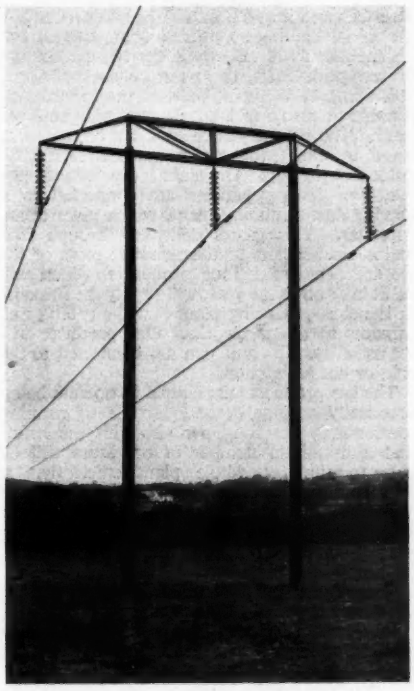
The National Physical Laboratory demonstrated a special-purpose digital computer. This small digital computer was developed for use in continuous checking of readings from cine-theodolite films. The machine adds together several input numbers, and derives the first difference of successive sums. An automatic typewriter prints the results of its operations together with some of the input numbers. The computer is a parallel six-decimal-digit machine employing relays and uniselectors throughout, the principles of operation being based on those of the R.A.E. sequence controlled calculator. As exhibited the input to the machine is by a keyboard, but it is designed to work directly from a semi-automatic film reader. It can also be easily extended to derive and print the second differences of successive sums. It was built by the Electronics Division of Saunders-Roe, Ltd., to a design by the National Physical Laboratory under a Ministry of Supply contract.

NEW FACTORY FOR SANITARY INCINERATORS.—A new factory has been opened at Fowler Road, Hainault, Essex, by Allied Metals, Ltd., for the manufacture of " Barrywald " sanitary incinerators distributed by its associate company, Saniguard Appliances, Ltd.

132kV Wood Pole Overhead Power Line

AMONG the extensions that are being made to the British Electricity Authority's 132kV transmission system is a single-circuit overhead line, between Carmarthen and Haverford West in South Wales, which is of special interest in that it is being carried on wood poles. Although the use of wood poles for voltages of this order, and higher, is a common practice overseas, this form of construction has not hitherto been used in Great Britain for an entire line at 132kV.

On the 27-mile route between Carmarthen and Haverford West there are a total of 276 pole locations, and the spans between them are normally 600ft. The poles used are of red fir and they



Straight Line Wood Pole Support for 132kV Overhead Line

vary between 40ft long by 10½in diameter, and 53ft long by 15in diameter. A typical straight line support is illustrated here. The cross arms, which are assembled on site, are of lattice steel construction, with pin-jointed fixing, and are bolted to the pole tops prior to erection. The two leg members of the " H " frame are spaced 16ft apart to give a separation of 16ft between phases.

Although there are no brace blocks or trussing tackle, kicking blocks are fitted to intermediate poles to provide an additional resistance to overturning ; they are attached to each leg at a distance of 18in below ground level.

The three line conductors are of normal Grid design and are of 0·175 square inch steel-cored aluminium, made up of an inner core of seven galvanised steel wires overlaid by thirty aluminium wires each of 0·11in diameter. The conductors are erected to a slightly higher tension than is generally used on Grid work, the tension at 40 deg. Fah. in still air being 4370 lb as against the normal grid tension for this size of conductor 3253 lb. Stockbridge vibration dampers are fitted adjacent to each insulator to deaden the line vibrations.

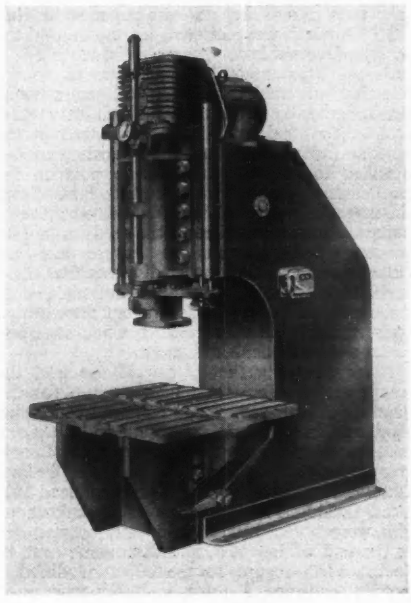
An interesting requirement of the line specification is that a means of earthing the line during maintenance periods should be readily available ; accordingly, an 0·1 square inch copper strand is turned six times round the pole butt to provide an earth and it terminates in a lug fitting arranged for easy attachment to the steel cross arm. This ready accessible earth is here preferred to the spike earths which would normally be used by the line maintenance gang. To retain the insulation value inherent in the wood pole construction, laminated wood insulators are fitted in all line stays.

This line, erected by British Insulated Callender's Construction Company, Ltd., 21, Bloomsbury Street, London, W.C.1, is probably the cheapest form of line construction yet built in this country for use at the standard grid voltage of 132kV. It will be interesting to learn of its performance in service and particularly to determine whether the unearthed construction offers any advantages over the normal steel tower construction so far as line outages are concerned.

Hydraulic Press

A NEW hydraulic press of 120 tons capacity, now being made by Finlay Engineering, Ltd., Newport, Mon, is illustrated below. This machine has a fabricated steel gap frame with a 48in square table, and it is fitted with a spring-return ram and cylinder assembly. Hydraulic fluid is supplied by a 10 h.p. motor directly coupled to a three-plunger pump at the top of the machine frame. The ram, which exerts a maximum pressure of 120 tons, has a stroke of 15in, the ram speed being 30in per minute when moving down and 60in per minute when returning. Plates 48in wide and up to ½in thick can be bent on the machine.

The press table is made with a detachable front section, to allow clearance immediately in front of the plate die for work with reverse bends. When this detachable section is in position



120-Ton Hydraulic Press

16 square feet of the surface is available for fixing dies and bending blocks.

The movement of the ram is controlled by treadle or hand lever and a stroke adjusting valve is provided for setting of the ram travel up to its maximum of 15in. The return stroke of the ram can also be set by means of an adjustable collar on a guide rod fixed to the ram head. The ram head is machined with a spigot register for alignment of tools or dies ; it also provides 90 deg. alternative mounting positions. The standard equipment incorporates a 48in plate bending blade and alternative bending block. A two-way plate bending die, 48in long, is also standard equipment and can be secured on the frame table in alternative 90 deg. positions.

The hydraulic system includes a spring-loaded safety valve and pressure gauge, marked in tons and kilogrammes. The hydraulic medium is a standard grade of light oil contained in the cistern, which houses the pump unit, and a depth gauge is provided for oil check.

Cathodic Protection of the Interior of Cargo Compartments in Oil Tankers

On Friday, March 26th, Mr. John Lamb, Mr. E. V. Mathias, and Mr. W. Godfrey Waite presented a paper before the North East Coast Institution of Engineers and Shipbuilders with the title "Cathodic Protection of the Interior of Cargo Compartments in Oil Tankers," which is summarised below.

Reference is made to an earlier paper upon the efforts made to combat internal corrosion in oil tankers and the theory of corrosion and cathodic protection is briefly expounded. Based upon the acceptance of the electro-chemical nature of corrosion, the principle of cathodic protection in tanks carrying sea water ballast is clear and since the steelwork acts as a cathode then, it is stated, independent anodes must be installed. Attention is drawn to the fact that corrosion also occurs when carrying "white" cargoes against which cathodic protection is of no value but it is suggested that under ballast conditions that current flow could be adjusted to cause the precipitation of an alkaline calcareous film on the steel surfaces and so give protection after the discharge of ballast. It is stated that anodes of a special magnesium alloy, containing small percentages of aluminium and zinc, were adopted since this material does not form a protective scale and provides the greatest current efficiency. To ensure the escape of the hydrogen evolved it was arranged either to leave hatch covers open or remove ullage plugs. The product formed by the dissolution of the anodes was not considered harmful to the cargo.

Favourable results with cathodic protection in a butane carrier influenced the decision to undertake tests in a tanker and the paper states that the "Auris" was selected as presenting the most unfavourable conditions. The scope of the tests are listed and the paper goes on to the question of the formulation of the scheme, which had to be simple to avoid high installation costs. The main anodes were placed at the bottom of the compartment and boosting anodes installed to remove scale and to polarize the steel surfaces and build up a surface film. Since the degree of protection is linked with the time in ballast, attention is called to the need for careful ballasting arrangements to ensure alternate ballast passages. The paper discloses that three current densities, low, medium and high, were arranged in separate tanks and an unprotected tank was selected as a control, while steel test plates were installed throughout.

After recording the history of the trial the results are discussed and figures given for the quantity of scale removed, an amount which was significant in terms of deadweight, and the paper goes on to point out that the removal of scale greatly facilitated the operation of gas freeing. Observations on the state of the bulkhead surfaces, including the condition of the calcareous film, were noted while the ship was on passage, at the end of the trial, and after some time in dock. With regard to the effect of different current densities a table in the paper gives potential measurements for the various tanks using a silver/silver-chloride half cell as a criterion for full protection. Although the calcareous film tended to flake away it was considered to have successfully retarded corrosion when the tank was empty, and a tabular statement records the loss in thickness of the steel test plates, figures which reveal the considerable protection afforded. The paper notes that gas oil did pick up some magnesium but that the amount was insignificant.

In reviewing the investigation it is claimed that, although the ballast periods were unfavourable to the tests a 75 per cent reduction in corrosion was achieved over the tank bottom structure, the figure diminishing towards the deckhead, a result which indicated the need to modify the anode distribution to obtain a more uniform spread of current. Further comment is made upon the loss in deadweight represented by the amount of scale and an economic appraisal given of the cost of repairs compared with that of installing a cathodic protection system. From the protection of "white oil" tanks the paper next considers the problem with respect to crude oil cargoes and it is stated that corrosion occurs mainly in tanks which are ballasted and that it is most severe in those cleaned before ballasting. So it is suggested that tank-washing should be reduced to a minimum. The importance of the waxy film formed on the surface of the structure is emphasised and since corrosion is slight in non-ballasted compartments the possibility of designing a tanker to take advantage of this fact is mentioned.

African Engineering News

(By Our South African Correspondent)

Industrial Gas Plant

One of South Africa's most modern and largest single industrial gas plants recently started production at the Vereeniging works of the Union Steel Corporation (of South Africa), Ltd., (USCO), the initial lighting-up process being carried out on January 17th. Designed for the gasification of low-grade fuels, the plant consists of seven 10ft diameter Wellman-Galusha producers, each capable of gasifying 1 ton of anthracite coal per hour. The volume of gas that can be manufactured by each producer amounts to 3,500,000 cubic feet per day. The plant is divided into two sections. Two producers are connected to a cooling and scrubbing plant, which gives clean, cold gas. This gas is delivered through 30in mains via boosters to the remotest parts of the works. The other four producers, which will be lit later on in the year, will supply the furnaces in the steel-producing plant and the rolling mill furnaces in the wireworks. One producer will act as a standby and can be connected to the cold or hot gas section.

The gas producers are simple to operate being practically automatic, and capable of running continuously for long periods, with the result that a minimum number of operators will be able to run the whole plant efficiently. A coal-handling plant has been built in so that the anthracite is handled automatically from the moment it arrives by rail truck. Each producer is a self-contained unit consisting of the following main parts :—

(*a*) An overhead fuel bin from which fuel is constantly supplied to the producer.

(*b*) A water-jacketed producer shell in which gasification takes place. Waste heat in the water jacket generates the steam required for saturating the blast, and dispenses with the necessity of providing any auxiliary steam or boiler plant equipment. The use of the water jacket also does away with the usual brick lining.

(*c*) A revolving grate which is mechanically operated.

(*d*) A conical ash bin in which ash is collected as it is automatically discharged from the grate.

The gasification process is a simple one, the principle being that supplies of raw coal are fed into the top of the producer, steam and air are blown through the red-hot coal to generate gas, and the ash is mechanically withdrawn at the bottom. The efficiency of the producers is approximately 90 per cent, i.e. about 90 per cent of the heat that can be liberated by burning the anthracite is recovered in the form of combustible gases and the sensible heat in these gases.

The quality of the gas is represented by an average calorific value of 150 B.Th.U. per cubic foot, as compared with the gas used for domestic purposes, which has an average calorific value of 450 B.Th.U. per cubic foot. This low calorific value gas is particularly suitable for industrial use where furnace temperatures are required up to 1250 deg. to 1300 deg. Cent. maximum. The gas now being produced at USCO is an ideal fuel for industrial heating operations, due to its uniformity, cleanliness and dependability. The hot and unwashed gas will be supplied to the steel-producing plant and the cold gas for distribution to the remote parts of the works, where it is impracticable to take supplies of hot gas.

It is the intention of the Union Steel Corporation to erect a number of new reheating furnaces and to convert some of the existing furnaces, which the gas plant will serve. The new furnaces to be erected are two pusher type billet reheating furnaces, two bogey type ingot heat-treatment furnaces, two heating furnaces for the sheet mill, one bar heat-treatment furnace, and one bogey type copper coil annealing furnace. The furnaces to be converted to gas firing are the copper billet reheating furnace, the rod mill billet reheating furnace, and other sundry reheating equipment.

Uganda's Copper and Cobalt Output

Production of copper and cobalt is likely to become the most important factor in the economy of Uganda. Some 9000 tons of copper and 450 tons of cobalt may be produced annually by the Kilembe mine, which is expected to start production in 1956. Total expenditure to complete the scheme to the production stage is estimated at £6,500,000. The cobalt concentrate will be processed at Kilembe, in Western Uganda, and cobalt-oxide shipped overseas for refining. Copper concentrate, after roasting at Kilembe, will be sent by rail to Jinja, on Lake Victoria, just below the Owen Falls, where an electric smelter will produce blister copper. The erection of the plants at Kilembe and Jinja will be started almost at once.

An agreement regarding finance has been reached by Frobisher, Ltd. (the Canadian mining house and subsidiary of Ventures, Ltd.), the Colonial Development Corporation and the Uganda Development Corporation. The Colonial and Uganda Corporations will subscribe £2,500,000 and the Frobisher company the balance.

Investment Casting Exhibition

An exhibition was held recently in London by Deritend Precision Castings, Ltd., illustrating its extensive range of castings made by the investment casting process. The company was formed to exploit this casting technique and has concentrated on its application using only high melting point alloys. There were over thirty exhibits chosen to represent components which would normally be regarded as impossible by other forming processes. With the exception of two all were made from steels in the following categories : case-hardening steels, mild and medium carbon steels, medium carbon alloy steels, spring steels, austenitic steels suited for either corrosion or heat resistant uses, martensitic stainless steels, nitriding steels, and tool and die steels. Two items needing extreme resistance to abrasion were cast in "Stellite." The company accepts dimensional tolerances of $\pm 0{\cdot}005$in, and normally only grinding is required on important dimensions. Most of the exhibits were of intricate shape and had weights ranging from fractions of an ounce to several pounds. The more important metallurgical advantages claimed for the process include the condition of the microstructure of the metal itself which is equiaxed, that the castings are normally non-stressed in cooling and no chill is formed on the surface. Castings are stated to exhibit a homogeneous structure and complete freedom from directional properties.

"Zirconiated" Tungsten Electrodes for Argon Arc Welding

"Zirconiated" tungsten electrodes have recently been developed by Murex Welding Processes, Ltd., Waltham Cross, Herts, for use in the argon arc welding process. These electrodes are stated to have the advantage of greater resistance to contamination than the pure tungsten and thoriated tungsten electrodes which have hitherto been generally used in this welding process.

The manufacturer states that even if the zirconiated electrode is deliberately allowed to touch the molten pool and the filler wire during welding, contamination, although present, does not "wet" the point of the electrode and form a globule on the tip, as in the case of pure tungsten and thoriated tungsten rods ; and that it is possible to continue welding with zirconiated electrodes after contamination when in similar circumstances pure tungsten and thoriated rods would require immediate regrinding.

Murex centreless ground zirconiated tungsten electrodes are now being made in the following sizes (outside diameter) and lengths :—$\frac{1}{16}$in by 6in, 8in and 12in ; $\frac{3}{32}$in by 6in and 8in ; $\frac{1}{8}$in by 6in and 8in ; $\frac{5}{32}$in by 6in ; $\frac{3}{16}$in by 6in and 8in ; $\frac{5}{32}$in by 8in.

Her Majesty's Yacht "Britannia"*

By SIR VICTOR SHEPHEARD, K.C.B., R.C.N.C.†

No. II—(*Concluded from page 569, April 16th*)

In this paper details of the planning, design and construction of Her Majesty's Yacht "Britannia" are given. The co-ordination of the requirements for both yacht and hospital ship is described, as are the exhaustive tests to determine the hull form, the design of propeller, the shape of the funnel, seaworthiness and the minimum dimensions. Particulars are recorded of the equipment and the paper includes plans of the general arrangement of the ship and of the machinery.

Pumping, Water and Oil Services

Three 70-ton-per-hour, motor-driven bilge pumps are fitted, one in each of the three main machinery spaces, also one 70-ton pump is fitted aft of the machinery spaces and one 20-ton pump forward. The 70-ton pump in the boiler-room is an emergency submersible pump with controls geared to above the main deck. Each pump can take suction from the sea, from the compartment in which it is situated, or from the main suction line, and discharge overboard or to the fire main.

An automatic sprinkler system is fitted throughout the after accommodation.

Tank stowage for 195 tons of fresh water is provided, and there are two evaporators with a total distilling capacity of 120 tons per twenty-hour day, and a 20-ton-per-day feed water distilling plant is fitted in the engine-room to provide make-up feed water. Two separate fresh water pressure supply systems are provided, one forward and one aft; two 10-ton-per-hour pumps supply the after system and one 10-ton pump the forward system. The water is chemically treated by the injection of chlorine into the filling main, and is pumped from the storage tanks through fine mesh filters to the pressure tanks and then to the fresh water main through carbon dechlorinators. A small quantity of lime is added to the water in the storage tanks to make it slightly alkaline and so protect the copper piping of the systems.

Separate hot fresh water systems are also fitted forward and aft, and each is heated by a 300-gallon steam calorifier with a heating capacity of 3000 gallons per hour.

Capacity is provided for 490 tons of fuel oil and 20 tons of diesel oil, and provision made for fuelling at sea, a rate of 250 tons per hour being expected.

Careful consideration was given to the sewage system since the ship, in either role, may be required to lie in restricted, perhaps non-tidal, harbours for long periods with her full complement on board.

Eventually two entirely separate sewage and waste water systems were fitted, one forward and one aft, so that the system aft will be able to shut down completely when it is not required.

Equipment

The boat complement consists of:

One 40ft Royal barge, two 35ft medium-speed motor boats, one 32ft motor cutter, two 27ft jolly boats (sea boats), two 16ft fast motor dinghies, two 14ft sailing dinghies, and all power boats are diesel driven.

In addition, "Britannia" carries eighteen life rafts of a self-inflating type and each holds twenty persons.

Two large derricks are provided amidships, heeling one each side at the base of the funnel. Power lifting and topping are operated by two two-ton winches.

Denny-Brown single-fin stabilisers are fitted in a compartment immediately forward of the main machinery spaces. The specification for the gear called for power to stabilise a roll of 20 deg. out-to-out reducing it to 6 deg. out-to-out at ship speed of 17 knots. The fins, which are retractable, are 4ft 6in wide, with outreach from the hull of 9ft 4in and area of 42 square feet each. They are capable of operating at the full ship speed of 22 knots at the maximum fin angle, which is 20 deg. The fins are run out, rotated and retracted by an electro-hydraulic system controlled from the bridge. The main controlling motor is a 37½ b.h.p. unit and the servo-motor a 10 b.h.p. unit.

The laundry has been designed to meet the requirements of the ship either as a Royal Yacht or as a hospital ship. Separate facilities are provided within the laundry to meet the requirements of the Royal party, and the steam consumption will be about 1100 lb per hour, the electrical load 18kW, and the estimated water consumption 3 tons per day.

An ornamental binnacle, originally from the "Royal George," has been taken from the "Victoria and Albert," fitted with a gyro repeater and mounted on the sun deck aft. The wheel from the racing yacht "Britannia" is used in the wheelhouse and has been suitably inscribed.

In addition, the following navigational aids are installed:—

M/F direction finder for general use; Decca navigator; Loran; navigational radar, type 974; commercial type electric log; echo sounder.

"Britannia" is exceedingly well equipped with radio. Four transmitting sets and their associated receivers are provided for m.f./h.f. transmission and reception. One set is provided with its own battery equipment for emergency use if all other power supplies, including the emergency generator, fail. The transmitters are designed to transmit in key or speech. A link is provided for ship-to-shore telephone communication and on certain 'phones speech can be scrambled for security purposes if required.

With the number of sets to be operated, whip aerials situated on the bridge and on the sides of the funnel have to be used in addition to roof aerials.

For the conduct of State business on board, cryptographic equipment is fitted in the cypher office.

Facsimile transmission is also installed.

Sound reproduction equipment is fitted throughout the ship with the choice of three programmes.

Main and Auxiliary Machinery

The choice of main machinery was limited to the selection of a modern well-proven unit which could be produced in a reasonably short time.

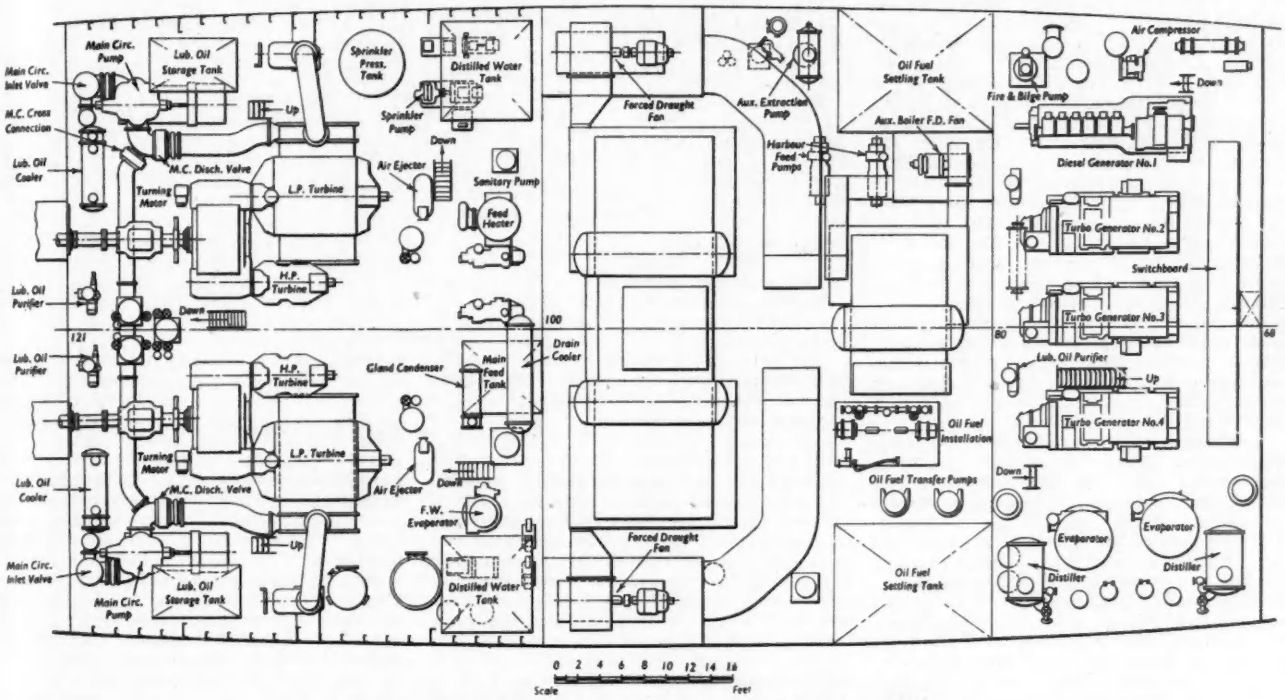


Fig. 3—Her Majesty's Yacht "Britannia," Layout of Machinery Spaces

A set of geared turbine machinery of power similar to that required for the Royal Yacht had been designed by John Brown and Co., Ltd., with the co-operation of the Pametrada and fitted in the cross-Channel steamers "Arnhem" and "Amsterdam," and this was taken as the basis for the machinery designed for "Britannia."

The machinery was developed from this basic design taking into account the following requirements:—The machinery to be capable of running at full power in both tropical and Arctic climates. Good habitability in the machinery spaces, in particular under tropical conditions. Arrangements to meet normal Service standards for steaming under gas attack conditions to be incorporated as far as possible, except where such arrangements would prejudice the function of the ship as a Royal Yacht; to enable the ship to be steamed under such conditions boiler combustion air has been trunked direct to the boilers; separate ventilation has been fitted to the open boiler-room which would be closed down under gas attack. Special precautions to be taken against shock damage from underwater explosions, cast iron being eliminated from all main and auxiliary machinery. The machinery

* Institution of Naval Architects' Spring Meeting. Abstract.
† Director of Naval Construction.

to be as smooth and silent running as possible and all avoidable vibration eliminated at its source; resilient mountings have been fitted beneath the diesel generator to reduce structural-borne vibration.

The layout of the machinery spaces is shown in Fig. 3, and the main boilers are so arranged that either boiler can steam both the port and starboard engines. The main machinery consists of two sets of turbines and gearing, each set comprising one h.p. turbine and one l.p. turbine in which is incorporated the astern turbine, all constructed by the shipbuilders. Single-reduction hobbed and shaved gearing is fitted, driving the shafts at 285 r.p.m. when the maximum power of 6000 s.h.p. per shaft is being developed. Full power revolutions of the h.p. and l.p. turbines are 4910 and 3550 r.p.m. respectively. The condensers, which are of the two-flow type, are underslung beneath the l.p. turbines and are supplied with circulating water by electrically driven pumps with a maximum capacity of 10,000 gallons per minute for each condenser. A conventional close-feed system is fitted using an auxiliary condenser in the boiler-room for harbour steaming conditions.

Steam is generated from two main boilers, each having a capacity of 75,000 lb per hour, at a pressure of 300 lb per square inch and a temperature at the superheater outlet of 660 deg. Fah. The boiler combustion air is trunked to the boilers and is drawn by electrically driven forced draught fans from a plenum space at the base of the funnel into which the exhaust ventilation from the boiler-room is discharged. Thus, warm ventilation exhaust from the boiler-room is fed to the boilers augmented by fresh air from the atmosphere drawn through slats in the plenum space. The exhaust gases from the boilers are extracted by electrically driven induced draught fans and discharged through grit arresters to the atmosphere. At full power the gases leave the funnel with a velocity of about 110ft per second and a temperature of 400 deg. Fah. It is essential for the efficient operation of the grit arresters and to keep the funnel discharge well clear of the ship, that a high efflux velocity of the exhaust gases be maintained under varying power conditions. This is obtained by hydraulic control from the boiler-room platform of the inlet flaps to the grit arresters, which allows the number of arresters in use to be adjusted to suit the power.

An auxiliary boiler is installed to meet harbour requirements. It has an evaporating capacity of 20,000 lb per hour at the same steam conditions as the main boilers, and can be used to augment the main steam supply.

The main and auxiliary boiler feed pumps and the main engine auxiliaries are electrically driven. Two salt water evaporating and distilling plants, each having an output of 60 tons per day, are fitted in the generator room and a 20 tons per day feed water evaporator is sited in the engine-room for make-up feed purposes.

The engine-room is ventilated by two axial-flow and two centrifugal supply fans with a total output of 30,000 cubic feet per minute, and three axial-flow exhaust fans with a total exhaust of 32,000 cubic feet per minute. The slight negative pressure in the engine-room should prevent warm air escaping into the ship through the engine-room entrances should they be open. The boiler-room is supplied by two axial-flow fans of 10,000 cubic feet per minute each, whilst the generator room has a fan supply and exhaust of 15,000 cubic feet per minute.

The steering gear is of the electro-hydraulic design with two separate motor-driven variable delivery pumps, either of which is capable of actuating the rudder under maximum torque conditions. The pumps are telemotor controlled from the wheel house and by mechanical control in the steering gear compartment. A separate hand-operated variable delivery pump is available for emergency operation of the gear.

The size and shape of the funnel were finally decided with the assistance of the Aerodynamics Division, N.P.L., who conducted wind tunnel tests. It was desired that the funnel should have a pleasing appearance, that the decks should be free from smoke and funnel gases, and that the funnel paintwork should not be discoloured by smoke and gases eddying in the vicinity of the funnel top. The most efficient funnel suggested by the wind tunnel tests was unacceptable on account of height and shape of top, and it is of interest to compare the design of funnel first tested (*A*) with that finally fitted (*B*), as shown in Fig. 4.

With funnel *A* there was a breakdown in smooth air flow around the funnel and considerable eddying around the top edge as soon as the wind direction became slightly off the bow. The eddies of smoke extended down the side of the funnel to the superstructure level. In funnel *B* the width is decreased by 4ft and a front of better aerodynamic section substituted. Although there is still a breakdown of smooth air flow round this funnel section, it occurs with the wind much further off the bow than with funnel *A*. The top of funnel *B* has a casing streamlined in the fore-and-aft direction with circular sections athwartships. These changes effected a great improvement in funnel performance, which was increased by grouping the uptakes instead of distributing them over the funnel top. A major factor in producing a clean ship is the high efflux velocity of the exhaust gases in the full and part-power conditions. Efflux velocities in this ship are high and vary between 110ft per second with power of 12,000 s.h.p. to 80ft. per second at 1000 s.h.p.

The dynamo load at sea was estimated to be approximately 730kW and the harbour diesel load about 250kW, and the following generators are fitted for lighting and power supplies:—Three 500kW steam turbo-generators, one 270kW diesel generator, one 60kW emergency diesel generator.

The d.c. installation is at a constant voltage of 225, all permanent wiring being on the two-wire two-conductor system with both poles insulated. To allow for maintenance of the diesel generator in harbour steam can be supplied from the auxiliary boiler to run one of the turbo-generators to cover the harbour load. The generators feed into a main switchboard in the generator room and distribution from the main switchboard to the various circuits is by double-pole circuit breaker, switches and fuses. The emergency diesel generator, together with its own starting battery, is situated in a shelter deck compartment. It feeds into a switchboard fitted adjacent to the generator and in an emergency will supply vital services.

A.C. services are supplied by two d.c./a.c. motor generators of output 35kVA, 230V, 50 cycles, single phase. An a.c. switchboard is fitted with two control panels to distribute the power required for radio, sound reproduction equipment, X-ray, cinema, and echo sounding. Two 220/24V, d.c./a.c. motor generators with control gear, a 24V secondary battery, and a switchboard are fitted in the low-power room for supplying the gyro compass equipment, log, telephones, gongs, alarm bells, &c. A permanent system of degaussing is fitted and is fed from the 225V system.

Sea Trials

A full programme of contractor's sea trials was successfully completed in November, 1953. During the measured mile speed trials on the Arran course a full speed of 22·85 knots was obtained with the ship at 4320 tons displacement and the machinery developing 12,400 s.h.p. at 289 r.p.m. The propulsive coefficient related to the naked hull e.h.p. deduced from the model results at full speed was 0·6. There was a moderate sea and wind speeds at times reached 50 knots, and the wind, more or less on the beam caused the ship to heel to leeward a few degrees, and rudder angle of about 4 deg. was necessary to maintain a steady course in the most adverse conditions.

Fuel consumption was measured during trials of four hours' duration, each at a steady horse-power. After making adjustments for the maximum sea-going auxiliary load likely to be met on service, the fuel consumption is estimated to be about 47 tons per day at 2800 s.h.p. and 117 tons per day at 12,000 s.h.p. In the load condition carrying 330 tons of oil fuel the endurance will be about 2100 miles at 20 knots and 2400 miles at the economical speed of 15 knots, with clean bottom. Using the extra fuel tank capacity available for long ocean passages and carrying 490 tons of oil fuel, the endurance is increased to approximately 3100 miles at 20 knots and 3560 miles at 15 knots.

Generally, vibration was very small. Maximum vibration was recorded on the upper deck at the extreme stern during full-power trials when the double amplitude of vertical vibration was at times 0·014in and of transverse vibration 0·006in. The frequency was four times the shaft speed and consistent therefore with excitation from the propeller blades.

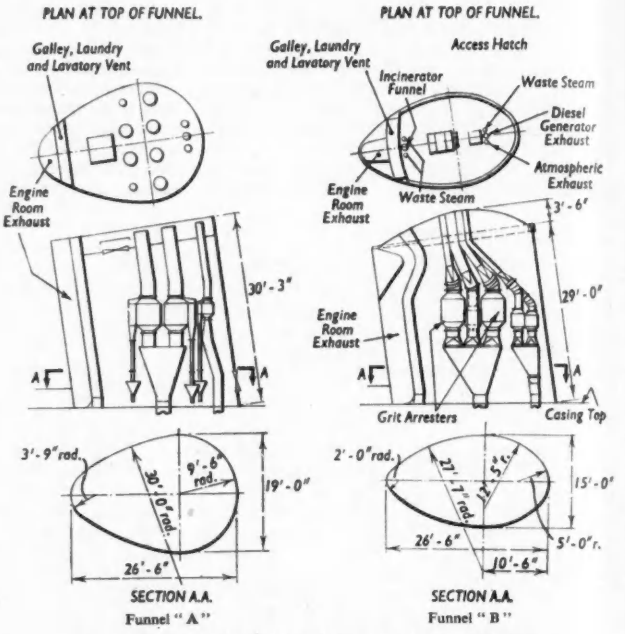


Fig. 4—Her Majesty's Yacht "Britannia" Funnel Design

Objectionable singing, which was traced to one propeller only, was experienced, and the spare propellers were shipped after having been modified by carefully machining the backs of the blades to finer edges. Considerable improvement resulted, but a note was still detected at a low speed. There was also a note at slightly higher speed, but this was eliminated by a small differential adjustment of propeller revolutions between the two shafts. The propellers now fitted have been accepted as an interim measure because the singing is at speeds lower than any likely to be used on passage.

Manœuvring and turning trials verified the ready response of the ship to the rudder. The tactical diameter at 21½ knots approach speed was 625 yards, i.e. five lengths, and the average rate of turn was slightly more than 1½ deg. per second. There was reasonable agreement between the port and starboard turns.

No really rough weather had been experienced by the ship at the time of preparing this paper, but the behaviour in the moderate sea and strong winds met on the sea trials was in all respects satisfactory and the ship was completely dry, apart from occasional spray. Forced rolling trials were carried out to test the Denny-Brown stabilisers, and the ship was rolled through a maximum angle of 30¾ deg. out-to-out at 21½ knots ship speed with the fins operating at an angle of 19½ deg. each way. Later, in heavy weather with rolling 40 deg. out-to-out, the stabilisers reduced the rolls to 10 deg. out-to-out.

Industrial and Labour Notes

Coal Prices

Last week, the National Coal Board announced that it had reviewed its policy for the pricing of coal and had reached the conclusion that, whilst the general basis must continue to be the inherent quality of the coal as shown mainly by the calorific value, that basis now required some modification. The Board feels that more account must be taken of the scarcity of certain coals and their high value in overseas markets, and in particular the scarcity of large coal which has had to be imported at high cost in recent years. Furthermore, the Board says, regard must be had not only to scarcity and value to the export trade, but also to unavoidably high costs of production such as those of carbonisation coals in certain areas.

The Board says that it would have preferred to have balanced an increase in the price of these coals with a reduction in the prices of other coals. In the present state of the Board's finances, however, it is regretted that reductions are not possible except in certain grades of house coal. In general, therefore, the effect of the price changes which the Board is making is that, on average, the price of large coal is to be increased by 6½ per cent, of carbonisation coal by 5 per cent, and of the rest by 3 per cent. On all inland coal the average increase will be about 4·8 per cent, or 2s. 10d. a ton. The new prices operate from May 3rd. The Board has stated that, as things stand at present, its accounts for the current calendar year are likely to show a deficit of £17,000,000, which is in addition to the deficit of about £14,000,000 accumulated from preceding years.

There is, the Board says, a variety of reasons for this anticipated deficit, one of the principal ones being the heavy additional capital charges brought about by increasing investment in reconstruction. This capital investment cannot, of course, fructify fully for some years to come, and further heavy expenditure is to be incurred on additional safety measures. Other items of added costs, the Board explains, include various increases beyond its control, such as increases in railway and local rates ; increases on research and education developments ; the production of briquettes and ovoids ; the grant to the new industrial fuel efficiency organisation, and local additions to pieceworkers' rates. The estimated deficit, however, does not take account of the recent increase of wages for day-wage men, the cost of which could be met by a 2½ per cent increase in coal production this year. As already stated, the National Coal Board and the National Union of Mineworkers consider that such an increase, with existing underground manpower, is a reasonable aim, and they are jointly pledged to take all practicable steps to secure it.

Federation of British Industries

The annual general meeting of the Federation of British Industries was held in London on Wednesday of last week, when Sir Harry Pilkington was re-elected president for a second year. Sir Harry, who is chairman of Pilkington Brothers, Ltd., is a member of the National Production Advisory Council on Industry, of the British Productivity Council, and of the steering committee of the Council of European Industrial Federations. He has made a special study of fuel efficiency and has taken a leading part in the establishment of the new National Industrial Fuel Efficiency Service.

The theme of Sir Harry's presidential address last week was confidence, based, he said, on a belief in the resilience, enterprise and vigour of British industry. In the past year, Sir Harry remarked, the spirit of enterprise had been manifest in many situations, and there had been new situations to face. The return to freedom implied the end of the sellers' market, and implied the return of conditions of struggle, effort and competition, bringing rewards to the successful and decline to those few who floated with the tide. Human endeavour and pride of achievement in emulation, Sir Harry added, were still two of this country's greatest assets.

In another part of his address, Sir Harry suggested that, in the next few years, British manufacturers would find the development of the less industrialised areas of the world, both in the Commonwealth and beyond, most significant. British industry was playing a big part in that dynamic expansion and in the creation of purchasing power abroad, and, Sir Harry affirmed, it could play a bigger part yet. Starting with capital works on an immense scale, that investment afforded opportunities, first, for the much greater export of capital goods and services, and then for the creation of greater markets for consumer goods. This country's own interests, Sir Harry said, as well as its full obligations to the Commonwealth on which so much depended, required it to retain and reinvest in the Commonwealth more overseas earnings. Industry, he asserted, must receive real encouragement from Governments here and abroad, protecting those investments from expropriation or from freezing. But, Sir Harry continued, we must also invest in this country. The whole conception of a dynamic economy meant that however much productivity here might rise through the elimination of waste, we should need, for years to come, to re-equip, to modernise and to expand, and to invest in plant, buildings and machinery. In order simply to retain our competitive power, more must be invested. Each man, Sir Harry commented, must be given more machinery and more power to increase his output, and, of course, he added, in an economy so tightly stretched, with full employment of people and pretty high employment of plant, enough could only be produced if the Government took less.

Nationalisation and the Engineering Industry

The annual conference of the Association of Engineering and Shipbuilding Draughtsmen was held at Brighton last week-end, and in his presidential address Mr. W. P. Stagg made a reference to the " plan for engineering " which was devised some time ago by the Confederation of Shipbuilding and Engineering Unions. He said that although the Trades Union Congress and the Labour Party had not yet accepted the plan the time would come when that would be changed.

Mr. Stagg went on to say that this plan for the extension of public control, including nationalisation, to certain sections of the engineering industry, was produced by the Confederation only after the most careful thought and consultation with its affiliated unions. The necessities of the situation would show that trade slumps, the abuses of monopoly and other features of capitalism could not be eradicated except by the extension of social ownership in the main industries of the nation.

Government Expenditure

Some observations on the need for a reduction of Government expenditure were made by Mr. C. H. Crabtree, chairman of R. W. Crabtree and Sons, Ltd., at the company's annual meeting last week. Mr. Crabtree said that the Chancellor of the Exchequer, in his Budget, had shown his desire to assist industry by the investment allowances, but the benefit of them was negatived by the continual high level of Government expenditure, both centrally and locally. Figures had recently been published showing that practically one-third of the gross national product was caught up in the Government tax net, whereas before the war only one-sixth was so trapped.

Mr. Crabtree went on to say that as an industrialist he realised how easily money could be spent and how necessary it was to have expenditure constantly under review. It was high time, he thought, that some definite action was taken to infuse the same sense of economy into Government departments. Government expenditure, he urged, must be ruthlessly curtailed in order to assist industry to meet the growing competition abroad, and to aid the growth of new ventures. It could not be overlooked, Mr. Crabtree added, that the present level of Government revenue had only been possible as a result of the continued prosperity of the post-war period. In the event of a serious recession of trade, the Government would soon find itself facing bankruptcy, and would have no alternative but to take " panic action " and curtail expenditure.

Industry at Harlow

The Harlow Development Corporation has recently published an illustrated book entitled *Harlow for Industry*, which contains information concerning the facilities offered for the establishment of factories in the Harlow New Town. The site designated for the town occupies 6000 acres and, when completed, the town will accommodate a population of 80,000. Considerable progress has already been made, more than 3500 houses now being complete, as well as a number of factories and other industrial establishments.

The first of two industrial estates has been well developed, and by the end of last year forty-two factories had been completed, while ten others were under construction. This estate occupies 100 acres. A second industrial estate, of 95 acres, is now being laid out for development. The book gives full details of the standard, intermediate and sectional factories which are available. It also includes particulars of leases and other formalities as well as general information about the housing and amenities of the town. The book is available, price 2s., from the Harlow Development Corporation, Terlings, Harlow, Essex.

Steel Deliveries and Stocks

In these notes in our last issue, some reference was made to a statistical survey of the British iron and steel situation which has been recently prepared by the Iron and Steel Board. Dealing with demands for finished steel, the survey says that pressure continues to be heaviest for flat products generally. In the first two months of this year, deliveries of plates averaged 51,000 tons a week, compared with 47,000 tons a week in the first two months of 1953. Stocks of plates held by consumers rose substantially both in the first and second half of 1953, the total increase during the year being about 105,000 tons. Deliveries of sheet from home production in the first two months of this year were at the rate of 38,000 tons a week, compared with 34,000 tons a week in the corresponding period of 1953. The Board says that output of sheets is likely to expand further in the second half of this year.

About imports and exports, the Board's survey shows that, at present, the principal steel imports are sheets, on which the duty is suspended. About 3000 tons a week were imported in the first two months of this year, against 1000 tons or so a week in the comparable period of 1953. But, the Board points out, the greater supplies of steel from home production have made it possible to reduce imports in general to a level close to that foreseen when the industry's first post-war development plan was drawn up. For delivery in the first half of this year, about 120,000 tons have been ordered on behalf of the steel industry and, in addition, a certain amount of steel (mainly sheet) is being imported directly by users. Exports of steel in the first two months of the present year, at 310,000 tons, were at about the same level as in the first two months of 1953.

Management Practices in Human Relations

The Industrial Welfare Society is arranging a " round table " for European executives on the subject of " Management Practices in Human Relations." It will begin at Robert Hyde House, 48, Bryanston Square, London, W.1, on Monday next, April 26th, and will continue until Friday, May 7th. This conference, it is stated, has a two-fold purpose. First, to present a picture of current practices and problems in the field of human relations in British industry, and, secondly, to allow for discussions in which delegates on the senior and middle management level, from all parts of Europe, will be able to exchange opinions and experience.

Notes and Memoranda

Rail and Road

INSTITUTE OF THE MOTOR INDUSTRY.—The Institute of the Motor Industry has recently re-elected Mr. Stanley S. Dawes, M.I.Mech.E., as its president. In appreciation of the services which he has rendered to the Institute, one of the scholarships for the motor industry's residential diploma course at Loughborough College of Technology is to be known as the Stanley S. Dawes scholarship. There are eight scholarships, each valued at £150 a year, in connection with this four-year course. Full particulars can be obtained from the Institute of the Motor Industry, 40, Queen's Gate, London, S.W.7.

MODERNISING BRITAIN'S ROADS.—The British Road Federation has published two booklets entitled "Loans for the Roads" and "Resources for the Roads." In "Loans for the Roads," the Federation supports the proposal for a road loan, to be administered by a National Highways Authority similar to other public corporations. The Federation submits that a road loan should be treated as any other loan for capital expenditure on a national service. In "Resources for the Roads," the Federation draws attention to the fact that plant and equipment costing £100 million is not now fully employed. Post-war programmes have passed their peak, it is stated, and a comprehensive road construction programme would mean the full use of all the resources of the civil engineering industry.

"POPULAR CARRIAGE" EXHIBITION.—The British Transport Commission has opened at Euston station a "Popular Carriage" exhibition, which traces the evolution of road and rail carriage design through two centuries by means of models and specimens of coaches, buses and railway carriages. The centre piece of the display is a handsome example of a fifty-years-old railway horse bus which was in regular service from Tenterden station, Kent, as recently as 1924. It was discovered a few months ago in an old stable and has since been repainted in its original bright green and yellow livery. Another exhibit of interest is a mock-up of part of the interior of a G.W.R. Royal Saloon of 1874, and there is also a full-scale reproduction of an old Midland Railway third-class compartment of 1875 with an outside communication cord and a special ceiling rack for top hats. The models have been arranged in two groups to show the development in design from the mail stage-coach of 1820 to the latest types of buses, trams and coaches, and from the horse-drawn railway carriage of 1826 to the most up-to-date British Railways cafeteria car.

Air and Water

GENERAL COUNCIL OF BRITISH SHIPPING.—At the annual meeting of the General Council of British Shipping Mr. H. Leslie Bowes, C.B.E., was elected chairman for the coming year and Mr. J. C. Denholm, C.B.E., and Mr. A. I. Anderson were elected joint vice-chairmen.

NEW PRESIDENT OF INSTITUTION.—We are informed that Professor A. M. Robb, of the John Elder Chair in Naval Architecture at Glasgow University, has been appointed to succeed Sir William Wallace as president of the Institution of Engineers and Shipbuilders in Scotland.

Miscellanea

MINIATURE SOLDERING TOOLS.—We are informed by the Anglo-Netherland Exchange, Ltd., 3, Tower Hill, London, E.C.3, that it is now supplying a new "Oryx" pencil type soldering tool with a $^{6}/_{32}$in bit. This tool operates on 6V and develops a bit temperature of nearly 400 deg. Cent. in about forty-five seconds, the consumption being 10W.

DESIGN CRITERIA FOR CONCRETE GRAVITY AND ARCH DAMS.—A booklet with the above title has been published by the Bureau of Reclamation of the United States Department of the Interior, Denver, Colorado. The basic criteria now used by the Bureau of Reclamation in the design of concrete arch and gravity dams are described and discussed in this publication.

NOTTINGHAM PUBLIC LIBRARIES.—A complete catalogue has been published of the books and periodicals concerned with mechanical engineering which are to be found in the Nottingham Public Libraries. In addition, the catalogue indicates that a collection of British patent specifications and a set of British Standard specifications are kept at the commercial library, South Sherwood Street, Nottingham.

MR. THOMAS ALLEN.—We regret to record the death of Mr. Thomas Allen, which occurred at Kingswinford, on April 9th, at the age of seventy-seven. Mr. Allen was formerly managing director of Gibbons (Dudley), Ltd., and Gibbons Brothers, Ltd., his association with those firms having begun more than sixty years ago. He was appointed a director of the first-mentioned company in 1912 and of the latter in 1919. Among his many other activities, Mr. Allen served as chairman of the Stourbridge Firebrick Association in 1922–23.

PROJECTION WELDING OF MILD STEEL.—A new publication, *Projection Welding of Mild Steel* has been issued by the British Welding Research Association. This booklet was prepared by a committee of the Association and covers all aspects of projection welding. Its recommendations are based upon extensive researches carried out over some years, and are made to cover the machines, electrodes and materials used; types of projections; and machine settings for various thicknesses of material. A section is included of suggested practices for projection welding based upon present industrial practice. Copies of the book can be obtained from the Association's offices at 29, Park Crescent, London, W.1, price 3s. 6d.

ELECTRICAL EQUIPMENT RECONDITIONING WORKS.—We are informed that Globelite Industries, Ltd., a subsidiary of Southern Areas Electric Corporation, Ltd., has recently moved into a new factory on the Marsh Barton Estate at Exeter. This company specialises in the reconditioning of electric motors and associated control gear, and the winding and rebuilding of transformers. The major part of the company's output is concerned with the repair of marine auxiliaries, and the new factory has been specially laid out to give a rapid reconditioning service.

INDUSTRIAL PRODUCTION.—The Central Statistical Office of the Treasury has announced that the index number of industrial production (1948 = 100) has been provisionally estimated at 126 for all industries in January, compared with a revised figure of 121 for December last. The corresponding figures a year earlier were 118 for January and 112 for December, 1952. Taking the manufacturing industries only, the index number for January this year has been estimated at 129, compared with 119 a year earlier. The Treasury says that on the basis of information so far collected, the index for all industries in February is expected to be 129 or 130. In February last year it was 122.

COASTAL ENGINEERING CONGRESS AT GRENOBLE.—Since 1950 the Council on Wave Research of the Engineering Foundation at the University of California has organised a series of conferences in the U.S.A. The 1954 conference will be at Grenoble (France), and it will be held on September 8 to 11, 1954. The president of the Congress will be the Dean of the University of California, Dr. O'Brien. The programme covers, generally speaking, the various problems raised by protection and development of sea coasts: study of the wave, coast formations, transport of suspended materials, planning and construction of sea structures. The last date on which papers can be accepted is June 30th. The local organising committee has the following address:—Coastal Engineering Congress, Ecole Nationale Supérieure d'Electrotechnique et d'Hydraulique, 44–46, Avenue Félix Viallet-Grenoble (France).

SOCIETY OF ENGINEERS.—The Society of Engineers is holding its centenary celebrations in London from May 4th to 7th, under the presidency of Mr. W. R. Howard, M.I.C.E. The celebrations will begin with a conversazione at the Science Museum, South Kensington, on May 4th. On the following day, at meetings to be held in the Geological Society's Rooms, Burlington House, Piccadilly, W.1, papers dealing with developments in civil, mechanical, electrical and aeronautical engineering will be presented by Sir Murdoch MacDonald, Mr. George Constantinesco, Sir Robert Watson-Watt, and Sir Roy Fedden. On May 6th, there is to be a trip on the River Thames, and the final event will be a centenary banquet at the Fishmongers' Hall on Friday, May 7th. At the banquet, the Churchill Gold Medal will be presented to Sir William Wallace, in recognition of his work in the development of ship stabilising gear.

BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION LUNCH.—The British Electrical Development Association held its annual luncheon at the Grosvenor House on Wednesday, April 14th. Mr. Geoffrey Lloyd, Minister of Fuel and Power, proposed the toast of "Electrical Progress." He referred in particular to the effects of electricity in the home and its extraordinary advantages in lightening the load that fell on the housewife. It alleviated, for example, the age-old labour of washing day and electric washing machines had a tremendous future. There was no doubt that the expansion of electric power would play a great part in furthering social advancement in this country. Sir Henry Solf, president of the Association, in reply, hoped that they could obtain higher efficiency and reduce the cost of generation. But the capital cost of new plant could only be carried by improving the load factor. Encouraging diversity of use was one way of doing so. The peak load could be reduced by increasing diversity. The electrical manufacturing industry was now the second largest exporting industry in this country. But a high export trade could not be maintained without a flourishing trade in the home market. Dame Caroline Haslett, chairman of the Association, proposed the toast of "The Guests," and Mr. H. Bishop, president of the Institution of Electrical Engineers, replied.

NON-DESTRUCTIVE TESTING OF CONCRETE.—A symposium on the non-destructive testing of concrete, which was attended by 140 specialists from twenty-two countries, was held in Paris, January 11 to 13, 1954, under the auspices of the Reunion Internationale des Laboratoires d'Essais et de Recherches sur les Materiaux et les Constructions. The programme was in four sections. The first section, on sonic tests, covered measuring apparatus and its scope of application and precision; quality control, a detection of defects, cracks, irregularities, construction joints, variations of composition and proportion, humidity, hardening, &c., reinforced concrete control, and the examination of corrosion and frost effects; the use of sonic measurements for evaluating mechanical properties, such as elasticity and strength, and their application to other materials and soils. The other three sections concerned superficial hardness tests and comparison with sonic tests; examination by means of gamma rays and neutrons; and possibilities of control of placed concrete by non-destructive methods. About forty technical papers were presented during the first two days of the symposium, while the final day was reserved for discussion. The proceedings of the symposium, presided over by Monsieur Robert L'Hermite, chairman of the R.I.L.E.M. Committee for Cement and Concrete Testing, are to be published in *R.I.L.E.M. Bulletins* in the first instance and then assembled in one or two special volumes.

Personal and Business

SHELL-MEX AND B.P., Ltd., announces the appointment of Mr. N. E. E. Murch as fuel oil manager of the eastern division.

MR. H. G. CONWAY, M.I.Mech.E., F.R.Ae.S., has been appointed chief engineer of Short Brothers and Harland, Ltd., Belfast.

THE BRITISH WELDING RESEARCH ASSOCIATION has appointed Mr. A. G. Thompson to make an investigation into welding productivity.

THE HAWKER SIDDELEY GROUP announces that it has purchased Canadian Steel Improvement, Ltd., Etobicoke, North Toronto.

ROUNDHAY METAL FINISHERS (LEEDS), Ltd., Roundhay Road, Leeds, 8, states that its telephone number has been changed to Leeds 656441.

MR. J. D. STRANKS has been appointed works director of Hawker Aircraft, Ltd. He has been the firm's chief experimental engineer since 1947.

THE NATIONAL SMOKE ABATEMENT SOCIETY, 30, Grosvenor Place, London, S.W.1, announces that its telephone number is now Sloane 6301.

MR. LESLIE GAMAGE, vice-chairman and joint managing director of the General Electric Company, Ltd., has been re-elected president of the Institute of Export.

SCOTTISH MACHINE TOOL CORPORATION, Ltd., has opened a Birmingham district office at 2, Sir Harry's Road, Edgbaston, Birmingham, 5 (telephone, Calthorpe 2541).

MARTONAIR, Ltd., Richmond, Surrey, states that Mr. R. A. Young has been appointed manager of its Birmingham office at 75, Holyhead Road, Handsworth, Birmingham.

INTERNATIONAL COMBUSTION (HOLDINGS), Ltd., states that Mr. R. H. Gummer has retired from active executive duties after nearly thirty years' service. He continues as a director of the company.

MR. A. R. E. ARNOT and Mr. R. G. Winton have been appointed directors of Lansing-Bagnall, Ltd., Basingstoke. Mr. H. P. Mott has been appointed materials and production controller.

MR. D. D. WALKER, managing director of Evershed and Vignoles, Ltd., has been appointed a director of the Iron Trades Employers' Insurance Association, Ltd., and Iron Trades Mutual Insurance Company, Ltd.

MATLING, Ltd., Wolverhampton, a subsidiary of A.B.C. Coupler and Engineering Company, Ltd., Wolverhampton, has opened new offices and showrooms at 28, Caxton Street, London, S.W.1 (telephone, Abbey 6652).

THE ENGLISH ELECTRIC COMPANY, Ltd., announces the appointment of Mr. H. M. Matthews, M.I.E.E., as director of engineering. He will take responsibility for the co-ordination and direction of the company's technical policy.

BABCOCK AND WILCOX, Ltd., states that Lieut.-Colonel P. D. Ionides has retired from the board after twenty-six years' service. Mr. W. F. C. Schaap, the company's chief engineer, and Sir Percy Mills, Bart., have been appointed directors.

MR. H. G. FOSTER, managing editor of *Electronic Engineering*, is leaving for the U.S.A. on May 3rd. He will be visiting the principal American and Canadian centres of research and development in electronics and expects to be away for seven weeks.

MR. J. P. H. READ, A.M.I.E.E., has been appointed chief engineer (machine section) of the Electric Construction Company, Ltd., Bushbury Engineering Works, Wolverhampton. Mr. F. S. Handley has been appointed assistant chief engineer (machine section).

VACUUM OIL COMPANY, Ltd., announces the following appointments at Coryton Refinery:—Mr. B. R. Fraser, manager; Mr. J. W. Bartholomew, assistant manager (process); Mr. W. Kohring, assistant manager (engineering); Mr. H. T. Fuller, superintendent of the operating division.

J. P. UDAL, Interlock Works, Court Road, Birmingham, announces that he has acquired a substantial interest in Industrial Guarding Equipment, Ltd. The two concerns will continue to operate independently on the home market, the present step having been taken to enable operations on a broader basis in the export field.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., announces the appointment of Mr. R. H. S. Turner as works manager, and Mr. A. Paterson as assistant works manager at the Trafford Park works. The company also announces that all its heating and welding activities have been incorporated in the welding engineering department, of which Mr. C. F. Saunders is chief engineer.

BRITISH RAILWAYS announce the following appointments in the London Midland Region:—Mr. N. R. Peach, district motive power superintendent, Crewe; Mr. G. E. Woodhead, district engineer, Derby (South), and Mr. J. Pollard, assistant district operating superintendent, London (Western). In the Western Region of British Railways, Mr. F. R. L. Barnwell, A.M.I.C.E., has been appointed district engineer, Newport.

THE PARKINSON AND COWAN group of companies states that, on April 30th, the electrical division of Measurement, Ltd., will be transferred to Parkinson and Cowan, Ltd., the parent company. On the same date Aspec (London), Ltd., will cease to trade as a separate company. The electrical division and Aspec (London), Ltd., will thenceforward operate under the title "Parkinson and Cowan Instruments (Incorporating Aspec), a Division of Parkinson and Cowan, Ltd."

British Patent Specifications

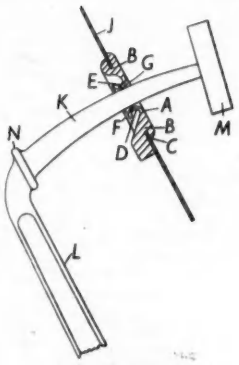
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

INTERNAL COMBUSTION ENGINES

706,051. October 12, 1951.—SEALING MEANS FOR MOTOR CONTROL PEDALS, The Austin Motor Company, Ltd., Longbridge Works, Northfield, Birmingham. (*Inventor: James Robert Stanfield.*)

The invention relates to the sealing of foot control pedals of motor and like vehicles. Referring to the drawing, the resilient member *A* comprises a moulded annulus of rubber or like material, the circumferential portion *B* of which is of considerable thickness so



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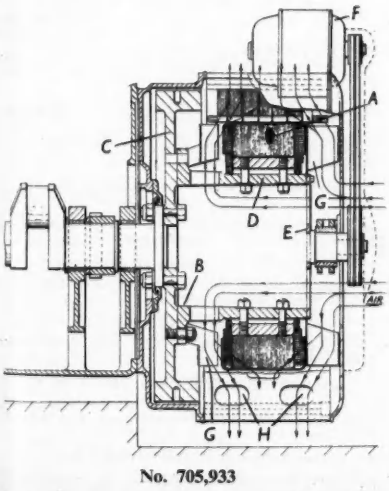
as to possess some rigidity, and the periphery is provided with an annular groove *C*. The central portion of the member is thinner than the circumference and is formed to provide a resilient sheath-like portion *D*, the lip *E* of which is directed toward the underneath face *F* of the member *A*. The sheath-like portion defines an opening *G* for the pedal stem *H*, as shown. The member is mounted in the hole in the toe-board *J* by engaging the groove *C* with the edge of hole. The pedal stem is an extension of a lever arm *L* beneath the toe-board, and the stem tapers from its point of connection with the lever arm, to its point of attachment to the pedal *M*. With this arrangement, when the pedal is held up by the usual spring, the widest portion of the pedal stem is surrounded by the sheath-like part of the resilient member, which is expanded somewhat and the best seal obtained. In the drawings is shown a collar *N* at the base of the pedal stem, which further enhances the seal.—*March* 24, 1954.

705,933. May 17, 1951.—ENGINE COUPLINGS, Blackstone and Co., Ltd., Rutland Engineering Works, Stamford. (*Inventor: George Hallewell.*)

The invention relates to the couplings of electrical generators to engines. From the drawing it will be seen that the generator shaft is dispensed with and the rotor *A* is carried on a bracket *B* bolted directly to the flywheel *C*. This bracket comprises a hollow



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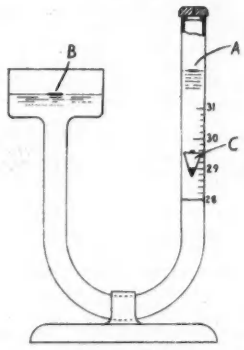
cylindrical member *D* with an annular flange at one end by means of which it is bolted to the flywheel. The rotor windings are bolted on to this portion. At the open end of the bracket is bolted a disc *E* which carries the slip rings and pulleys for driving the exciter *F*. This disc has large holes cut through it to allow a free and copious supply of air to be drawn in by fan blades *G*, and to direct it over the rotor and stator windings. The air takes the path indicated by the arrows and emerges through holes *H* in the stator casing. There is no generator outer bearing, the rotor *A* being overhung from the engine crankshaft. The torsional stresses are said to be reduced considerably with this construction so that greater bending stresses are permissible within the safe limits of shaft stressing.—*March* 24, 1954.

MEASURING INSTRUMENTS AND DEVICES

704,624. June 19, 1951.—A BAROMETER, John Stanley Jowitt, Unitarian Buildings, Market Place, Kendal, Westmorland.

The invention relates to a new type of barometer, smaller and cheaper than an ordinary mercury instrument. As the drawing shows, it consists of a U-tube on a stand, the total height being about 4in. On the left-hand side of the tube is the reservoir



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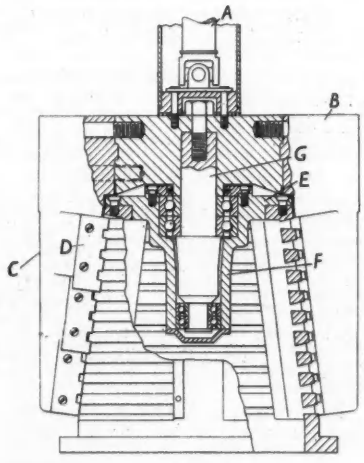
with its liquid level mark. The right-hand tube is closed with a cap having a capillary hole in the centre. On this tube is the graduated scale, 1½in in length, divided into lengths from 28in to 31in as in a standard barometer. The U-tube is filled with water on the reservoir side, and with methylated spirit on the scale side, the meniscus between the two liquids being at 28in and the upper surfaces of the two liquids at the index marks *A* and *B*. A conical float *C* with a lead tip floats in the methylated spirit. The lead float tip, which is about one-third the length, can be adjusted in weight to give a reading which is the same as that of a standard barometer. It is found that the indications of the float follow closely the variations of atmospheric pressure.—*February* 24, 1954.

SEWAGE DISPOSAL

706,062. January 7, 1952.—DISINTEGRATORS FOR SOLID SEWAGE MATTER, Jones and Attwood, Ltd., Titan Works, Stourbridge. (*Inventors: William Geoffrey Prescott and Hugh Lorain Folkes.*)

The invention relates to apparatus used in sewage disposal plants for disintegrating the solid matter contained in sewage. Referring to the drawing, the



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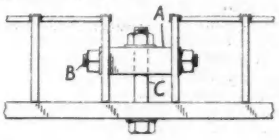
screen is of truncated conical form having its larger end at the base. It is fixed in a sewage culvert so that the stream of sewage can flow into the screen through its sides and pass out through its base.

Coaxially with the upper end of the screen is mounted a rotary vertical driving spindle *A*. At the lower end of the spindle is arranged a rotary head *B* which extends over the top of the screen, and from the head depends at least one cutter arm *C*. Preferably two or more arms are provided. On each arm is secured a series of cutter blades *D* with a notched cutting edge as shown. The top of the screen is enclosed by a cover plate *E* from which depends into the screen a hollow boss *F* serving as a bearing for a supporting spindle *G*, which extends down from the rotary head *B*. The driving spindle *A* is articulated and is connected to the rotary head by universal joints, this spindle being enclosed by a protecting sleeve *H*. By the use of a stationary screen and a rotary cutting blade or blades, an advantageous simplification of construction can be effected, as compared with a rotary screen and fixed blades, both in the comminutor itself and in the structure of the culvert in which it is mounted.—*March* 24, 1954.

STRUCTURAL ENGINEERING

704,790. July 5, 1951.—FLOORS OR PLATFORMS, Frederick Gilbert Mitchell, 1, Bedford Square, London, W.C.1.

The object of the invention concerns a method of fastening together the sections of flooring as described in a prior Specification No. 676,816, in which a grid-like structure of metal plates is used to form beams which are spaced by the strip metal binders at the



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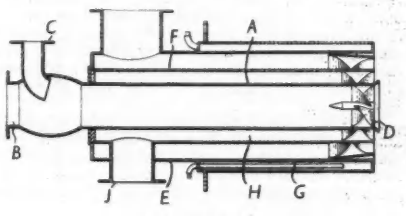
top as shown in the drawing. The connecting member, according to this invention, consists of a steel bar *A* of rectangular section having threaded end portions *B*. When the connecting member is inserted and its nuts are tightened, the beams are correctly spaced and fixed to each other. At the centre of the bar *A* a hole is drilled to take the bolt *C* which passes through a hole in the joist to secure the beam structure to the joists. Alternate designs are also shown in the specification.—*March* 3, 1954.

BURNERS AND SPRAYERS

704,901. August 7, 1951.—PULVERISED FUEL BURNERS FOR CEMENT KILNS, Pollopas Patents, Ltd., 79, Davies Street, London, W.1, and Hans Burg, of 325A, Rellinghauserstrasse, Essen, Germany.

The invention relates to burners for pulverised fuel and has for an object to provide an improved furnace burner which is particularly suitable for use in cement kilns and similarly constructed furnaces.



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As will be seen from the drawing, the burner comprises a tube *A* with an air inlet *B* and a pulverised fuel inlet *C*, both of which are outside the furnace. These lead to the burner orifice *D* having a helical deflector and guiding elements which impart a clockwise rotation to the air and fuel mixture. Secondary air is supplied through a second tube *E* coaxial with the burner tube *A*, and there is also a third tube *F* for the supply of gaseous fuel. By these tubes there are formed two annular passages *G* and *H* which terminate in annular orifices with deflectors as shown, and are at the outer ends provided with inlets for secondary air and fuel gas *J*. The part of the burner entering the furnace has an external water jacket which cools the burner casing. In operation the jet of pulverised fuel and primary air leaving the burner orifice *D* is surrounded by a sleeve of fuel gas, which, in turn, is surrounded by a sleeve of secondary air moving and rotating in the same way as the jet of fuel and primary air. By this means any unburned particles of fuel thrown out by centrifugal force form the core flame are surrounded by an ample amount of secondary air to ensure complete combustion.—*March* 3, 1954.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

FERROUS PIPES AND PIPING INSTALLATIONS FOR AND IN CONNECTION WITH LAND BOILERS

No. 806 : 1954. Price 10s. 6d. This standard supersedes the 1942 edition. It applies to the design and construction of the ferrous pipework connecting a land steam boiler to engine, turbine or industrial plant and all auxiliary pipework in connection therewith, together with the pipes and pipe fittings forming parts of such installations for pipes of any bore where the pressure exceeds 50 lb per square inch or pipes over 10in bore for steam at pressures up to and including 50 lb per square inch. This standard does not apply to the use of carbon steel where the temperature exceeds 900 deg. Fah., or to the use of alloy steel where the temperature exceeds 975 deg. Fah. The scope of this standard has been extended to provide for developments which have taken place in pipework installation practice, notably in the use of alloy steels.

Material specifications are included for :—

Class A, cold-drawn seamless carbon steel pipes.

Class B and C, hot finished seamless carbon steel pipes.

Class D, hydraulic lap-welded carbon steel pipes.

Class E, roll lap-welded carbon steel pipes.

Class F, butt-welded carbon steel pipes.

Class M, cold-drawn seamless molybdenum steel pipes.

Class P, cold-drawn seamless chromium-molybdenum steel pipes.

Class Q, hot-finished seamless chromium-molybdenum steel pipes.

Sections deal with :—

(i) Design requirements.

(ii) Procedure to be observed in the manipulation and fabrication of alloy steel pipes.

(iii) Construction including the attachment of flanges.

This standard also contains appendices covering *inter alia* :—

(i) Young's modulus for steel pipes.

(ii) Percentage elongation on various gauge lengths.

(iii) Diameters and thicknesses of steel pipes applicable to this standard.

(iv) Pressures in safety valve discharge piping.

(v) Examples of reinforcement of multiple branches.

METHODS OF TESTING RAW RUBBER AND UNVULCANISED COMPOUNDED RUBBER. PART 2, METHODS OF CHEMICAL ANALYSIS

No. 1673 : 1954. Price 7s. 6d. During the revision of B.S. 903, "Methods of Testing Latex, Raw Rubber and Unvulcanised Compounded Rubber," originally published in 1940, it became evident that it would be desirable to issue the revised standard as a number of separate publications. In the above standard forming one of this series of publications details of the following methods of determination are given : moisture (including volatile matter) ; acetone extract ; acid value ; alcoholic potash extract ; rubber hydrocarbon ; calculation of rubber hydrocarbon content by difference ; nitrogen ; total sulphur (carius method, fusion method and combustion method) ; extractable sulphur (nitric acid method and copper spiral method) ; insoluble matter and dirt ; ash ; wet oxidation; antimony; manganese; copper (over 10 p.p.m.); iron.

It has not been thought necessary to include all the analytical procedures which may be needed for compounded rubber stocks since many of these are similar to those used for vulcanised rubber ; these methods are given in B.S. 903, "Methods of Testing Vulcanised Rubber."

Launches and Trial Trips

BALLARAT, cargo ship ; built by Alexander Stephen and Sons, Ltd., for the Peninsular and Oriental Steam Navigation Company ; length between perpendiculars 490ft, breadth moulded 69ft, depth to shelter deck 43ft, load draught 29ft 9in, deadweight 12,790 tons ; six holds, 5 and 10-ton derricks, and one 80-ton derrick, electric deck machinery ; one set of double-reduction geared, triple-expansion turbines, service power 11,000 s.h.p., maximum power 13,000 s.h.p., steam supplied at 500 lb per square inch and 800 deg. to 856 deg. Fah. by two Foster-Wheeler boilers, service speed 18 knots. Launch, April 6th.

ROMANIC, cargo ship ; built by Smith's Dock Company, Ltd., for the Bolton Steam Shipping Company, Ltd.; length between perpendiculars 426ft, breadth moulded 59ft, depth moulded to upper deck 38ft 3in, deadweight 10,000 tons on 26ft 3in draught, service speed 11·5 knots ; five cargo holds, 5-ton derricks, steam deck machinery, three 40kW steam-driven generators ; triple-expansion steam engine and Bauer-Wach turbine, 3000 i.h.p., steam supplied at 600 deg. Fah. by three multi-tubular cylindrical boilers. Launch, April 6th.

PENVERN, ore carrier; built by the Ateliers et Chantiers de la Loire for the Chargeurs de l'Ouest ; length between perpendiculars 385ft, breadth moulded 54ft 2in, depth to shelter deck 30ft 6in, load draught 24ft 8in, displacement 10,600 tons, deadweight 7500 tons, service speed 11·5 knots ; four holds, eight 5-ton and two 10-ton derricks, steam deck machinery, two 160kW turbine-driven generators, one 60kW diesel-driven generator ; one set of geared Rateau turbines, 3000 s.h.p., superheated steam supplied at 285 lb per square inch and 715 deg. Fah. by two three-drum, oil-fired Proudhon-Capus Boilers. Trial, April.

Catalogues

TROPICAIRE, Ltd., Waterside Works, Ashford Common, Ashford, Middlesex.—Brochure describing a system for direct air industrial heating.

ADAMS-HYDRAULICS, Ltd., 15, Dartmouth Street, Westminster London, S.W.1.—Booklet describing marine sewage systems for overboard discharge.

FUNDITOR, Ltd., Woodbridge House, 3, Woodbridge Street, London, E.C.1.—Leaflets describing the Funditor metal loader and industrial electric furnaces.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

BRITISH INSTITUTION OF RADIO ENGINEERS

Tues., April 27th.—W. MIDLANDS SECTION : Technical College, Wulfruna Street, Wolverhampton, "Radio Telephone Equipment," T. C. Howell, 7.15 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs. to Fri., May 6th to 7th.—Grand Hotel, Harrogate, Annual Conference, 1954.

INCORPORATED PLANT ENGINEERS

Mon., April 26th.—MERSEYSIDE AND N. WALES BRANCH : Radiant House, Bold Street, Liverpool, Chairman's Address, 7.15 p.m. W. AND E. YORKSHIRE BRANCH : The University, Leeds, "Fluid Drive in Industrial Application" E. C. Farrer, 7.30 p.m.
Thurs., April 29th.—SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, Papers by Members, 7.30 p.m.
Fri., April 30th.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, "Welding," F. A. Thomas, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Sat., April 24th.—BRISTOL AND W. OF ENGLAND BRANCH : Grand Hotel, Bristol, Annual General Meeting, 3 p.m.——LANCASHIRE BRANCH : Engineers' Club, Albert Square, Manchester, Annual General Meeting and Election of Officers, Short Paper, Foundry Brains Trust, 3 p.m.——W. RIDING OF YORKSHIRE BRANCH : Technical College, Bradford, Annual General Meeting and Election of Officers, Open Night, 6.30 p.m.
Wed., April 28th.—LONDON BRANCH : Waldorf Hotel, W.C.2, Annual General Meeting, Film, 7 p.m.

INSTITUTE OF FUEL

Thurs., April 29th.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "The New Education Scheme of the Institute of Fuel," D. T. A. Townend, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., April 27th.—85, Minories, London, E.C.3, "New Metals in Engineering," L. B. Pfeil, 5.30 p.m.
Mon., May 3rd.—JUNIOR LECTURE : 85, Minories, London, E.C.3, "Marine Diesel Engines : Harland and Wolff Types," C. C. Pounder, 6.30 p.m.

INSTITUTE OF METALS

Mon., April 26th.—Royal Institution, Albemarle Street, London, W.1, Annual May Lecture, 6 p.m.

INSTITUTE OF NAVIGATION

To-day, April 23rd.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Surface Currents and Their Effects on Navigation," E. W. Barlow and C. E. N. Frankcom, 5 p.m.

INSTITUTE OF REFRIGERATION

Tues., April 27th.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Valve Behaviour and the Performance of Small Compressors," J. F. T. MacLaren, 5.30 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., April 26th.—SCOTTISH CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, Annual General Meeting, 7.30 p.m.
Tues., April 27th.—N.E. OF ENGLAND GROUP : Royal County Hotel, Durham, Annual General Meeting, 7 p.m.

INSTITUTE OF WELDING

Wed. to Sat., April 28th to May 1st.—SPRING MEETING : Wed., April 28th : Grand Pavilion, Porthcawl, Informal Gathering and Technical Film Show.—Thurs., April 29th, morning : Grand Pavilion, Porthcawl, "Steelmaking and Welding," L. Reeve; "Hydrogen: Barrier to Welding Progress," C. L. M. Cotrell ; afternoon : Visit to the Abbey Works of the Steel Company of Wales, Ltd., Port Talbot.—Fri., April 30th, morning : Grand Hotel, Bristol, "Nitrogen-Arc Welding of Copper," E. Davis and C. A. Terry ; "Nitrogen-Arc Welding of Copper," K. Winterton ; afternoon : Choice of Works Visits ; evening : Grand Hotel, Bristol, Dinner.—Sat., May 1st, morning : Grand Hotel, Bristol, "Welding in the Aeroengine Industry : Reflections on Organisation by a Production Engineer," F. G. C. Sandiford ; "Welding as a Career," F. Koenigsberger.

INSTITUTION OF CHEMICAL ENGINEERS

Fri., April 30th.—May Fair Hotel, Berkeley Street, London, W.1, Thirty-Second Annual Corporate Meeting, 11 a.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., April 27th.—ORDINARY MEETING : Great George Street, Westminster, London, S.W.1, James Forrest Lecture, "The Geological Survey of Great Britain," W. J. Pugh, 5.30 p.m.
Fri., April 30th.—YORKSHIRE ASSOCIATION : Royal Victoria Station Hotel, Sheffield, Annual General Meeting, "Land Drainage in England and Wales," E. A. G. Johnson, 7 p.m.
Tues., May 4th.—PUBLIC HEALTH MEETING : Great George Street, Westminster, London, S.W.1, "River Severn Scheme for the Water Supply of Coventry," R. C. G. Hetherington and J. C. A. Roseveare, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, April 23rd.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on "A Method for the Plotting of Magnetic Fields Due to Currents," opened by F. T. Chapman and D. G. Sandeman, 5.30 p.m.
Mon., April 26th.—RADIO SECTION : Savoy Place, London, W.C.2, "The Experimental Synthesis of Speech," W. Lawrence, 5.30 p.m.
Tues., April 27th.—MEASUREMENTS SECTION : Savoy Place, London, W.C.2, "Auto-Self-Excited Transductors and Push-Pull Circuit Theory," A. G. Milnes and T. S. Law, "Composite Cores for Instrument Transductors," E. H. Frost-Smith and A. E. De Barr, 5.30 p.m.
Wed., April 28th.—SUPPLY SECTION : Savoy Place, London, W.C.2, "Aluminium Sheathed Cables," P. M. Hollingsworth and P. A. Raine, 5.30 p.m.
Thurs., April 29th.—ORDINARY MEETING : Savoy Place, London, W.C.2, Kelvin Lecture, "The Physics of the Ionosphere," J. A. Ratcliffe, 5.30 p.m.
Mon., May 3rd.—S. MIDLAND CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, "Safety in the Use of Portable and Transportable Electrical Equipment in Industry," J. W. Bunting, 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, April 23rd.—GENERAL MEETING : 1, Birdcage Walk, Westminster, London, S.W.1, James Clayton Paper, "A New Frontier : Air-Pollution Control," Frederick S. Mallette, 4.15 p.m.——SOUTHERN A.D. CENTRE : The University, Southampton, Annual General Meeting, 7.30 p.m.
Mon., April 26th.—N.W. BRANCH : College of Technology, Sackville Street, Manchester, James Clayton Paper, "A New Frontier : Air-Pollution Control," Frederick S. Mallette, 6.45 p.m.
Wed., April 28th.—EDUCATION GROUP DISCUSSION : 1, Birdcage Walk, Westminster, London, S.W.1, "The Mathematical Content of Engineering Courses," 6.45 p.m.——E. MIDLANDS BRANCH : Technical College, Lincoln, "Contemporary Methods of Watch Production," R. A. Fell and P. Indermuhle, 7.30 p.m.——WESTERN A.D. CENTRE : Grand Hotel, Bristol, Annual General Meeting and Film Show, 7 p.m.——EASTERN A.D. GRADUATES' SECTION : Town Hall, Luton, Annual General Meeting, "Torsional Vibrations," A. Thomson, 7.30 p.m.
Thurs., April 29th.—SCOTTISH BRANCH : Royal Technical College, George Street, Glasgow, "A New Frontier : Air-Pollution Control," Frederick S. Mallette, 7.30 p.m.——SOUTHERN BRANCH : Municipal College, Anglesey Road, Portsmouth, "Combustion in Compression-Ignition Oil Engines," S. J. Davies, 7 p.m.——E. MIDLANDS A.D. GRADUATES' SECTION : Boy Scout Hall, North Church Street, Nottingham, "The Mechanism of Convective Heat Transfer and its Role in Gas Turbines," D. G. Wilson, 7.15 p.m.
Fri., April 30th.—GENERAL MEETING, AUTOMOBILE DIVISION AND APPLIED MECHANICS GROUP : 1, Birdcage Walk, Westminster, London, S.W.1. "Nodular Cast Iron : Its Present Position and Future Prospects as an Engineering Material," S. B. Bailey, 5.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Tues., May 4th.—ORDINARY MEETING : Institution of Electrical Engineers, Savoy Place, London, W.C.2, "Short-Wave Directional Aerial Systems," D. W. Morris, W. G. Shaddick and E. W. Thurlow, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., April 26th.—MANCHESTER SECTION : Reynolds Hall, College of Technology, Sackville Street, Manchester, "Modern Gear Production," H. J. Watson, 7.15 p.m.
Tues., April 27th.—LUTON SECTION : Town Hall, Luton, "Packaged Power," Film and Lecture, 7.15 p.m.
Wed., April 28th.—SHREWSBURY SECTION : Walker Technical College, Oakengates, Shropshire, "How the Production Engineer Can be Helped by Research," P. Spear, 7.30 p.m.

IRON AND STEEL INSTITUTE

Mon. to Thurs., April 26th to 29th.—MEETING OF JUNIOR ENGINEERS : Buxton, Derbyshire.

JUNIOR INSTITUTION OF ENGINEERS

To-day, April 23rd.—ORDINARY MEETING : Townsend House, Greycoat Place, London, S.W.1, "Engineering Maintenance in a Paper Mill," N. A. Holmes, 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, April 23rd.—Mining Institute, Neville Hall, Newcastle upon Tyne, "Some Practical Effects of Tip Clearance in Turbine Blading," J. L. Jefferson, 6.15 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., April 27th.—SECTION LECTURE : 4, Hamilton Place, London, W.1, "Aerodynamic and Aero-Elastic Characteristics of the Crescent Wing," G. H. Lee, 7 p.m.
Tues., May 4th.—SECTION LECTURE : 4, Hamilton Place, London, W.1, "Propellers for High-Speed Aircraft," G. C. I. Gardiner, 7 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Mon., May 3rd.—ORDINARY GENERAL MEETING : 12, Great George Street, Westminster, London, S.W.1, "The Changing Constitution," R. G. Fitzgerald, 5.30 p.m.

SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS

Mon., April 26th.—Mappin Hall, The University, St. George's Square, Sheffield, 1, Film Evening, 7.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Tues., May 4th.—Burlington House, Piccadilly, London, W.1, Annual General Meeting, 6.30 p.m.

SOCIETY OF ENGINEERS

Thurs., April 29th.—INFORMAL MEETING : 17, Victoria Street, London, S.W.1, Debate, 5.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., April 27th.—MAIN MEETING : Manson House, Portland Place, London, W.1, "Instruments for Testing and Control in the Textile Industry," S. L. Anderson, 6.30 p.m.

WOMEN'S ENGINEERING SOCIETY

Tues., April 27th.—LONDON BRANCH : 35, Grosvenor Place, London, S.W.1, "Use of Models in Ship Design," D. J. Doust, 7 p.m.
Wed., April 28th.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, "Some Aspects of Marine Propulsion," F. A. Fawcett, 6.45 p.m.